PETROLEUM REFINING • PETROCHEMICAL MANUFACTURING • GAS LIQUID RECOVERY

JULY, 1957

Petroleum Processing

Tidewater's Delaware Refinery

The complete technical story

Processes . . . p 99

Services . . . p 130 • Plant and People . . . p 159

32 detail-packed feature articles prepared and presented by the editors of PETROLEUM PROCESSING. The result of personal interviews with over 35 Tidewater staff and operating men, information memos from 22 specifically assigned C. F. Braun & Co. men, and articles by engineers of seven other engineering companies

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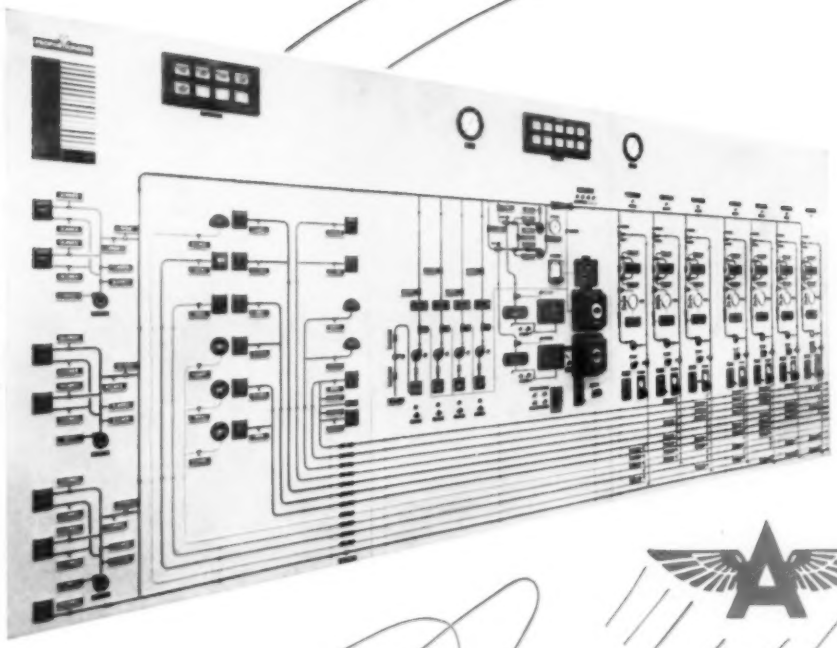

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TABLETS

SPHERES

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Reader's Guide

What's New in Petroleum

Tidewater's Delaware Refinery

The complete technical story

And it's a big one—72 pages long. In fact, it fills the entire feature section this month. This value-packed story—actually 32 separate articles—is one of the most unusual projects you'll ever find in a technical magazine. It's a report in depth by our whole editorial staff, with the help of about 75 engineers and processing men. (See p. 7 for more details on how we did the job.)

The story is so big that all phases of refining are covered—process, services, plant, and people. There's something for each reader. That's why this issue's contents pages were changed somewhat, eliminating the key number system normally provided to help you select reading of value to you.

You will read the details of the giant refinery from before construction began up to its latest features in the 32 articles listed in the adjoining table of contents.

We hope you'll find it rewarding reading.

INTRODUCTION

by W. F. Bland ..... p. 99

"In designing the new refinery, Tidewater management adopted a somewhat novel philosophy. . . . The whole approach was, 'don't accept anything at face value'."

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SUBSCRIPTIONS are solicited only from executives, supervisors, engineers, and other technical personnel engaged in petroleum and petrochemical research and development, and in the design and engineering, operation, maintenance and construction of petroleum refining, petrochemical processing and gas-liquids-recovery plants. **Position and company connection must be indicated on subscription orders.**

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AND WHAT'S AHEAD

Watch those future issues

You won't want to miss a single copy of upcoming issues of your favorite magazine. We've planned a continuous flow of new and helpful articles.

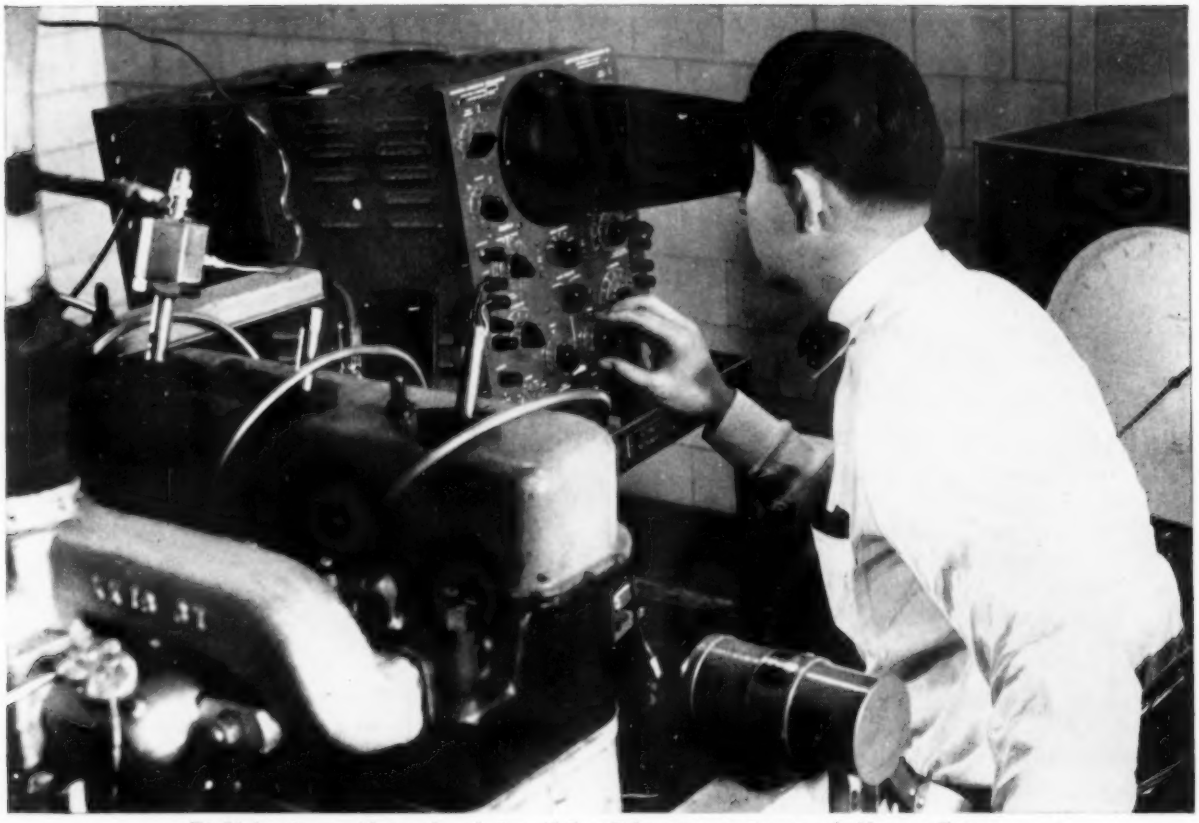
For example:

- Our second special industry report of the year. Scheduled for September this will include our sixth annual survey of the petrochemical plants in the U.S. and Canada, plus timely discussions of currently important petrochemical products.
- Later this year, two more special reports you'll want to read and keep—one on radiation and the other on furnaces.

Continue "Reader's Guide" on p. 179

USING READER'S SERVICE

Do you know that PETROLEUM PROCESSING has a Reader's Service Department? And that in every issue of PETROLEUM PROCESSING there's a Reader's Service Card to help you take advantage of the services offered? This card, on pp. 231 and 232 of this issue, tells you how you can get more information on products and literature described in our new products and new literature sections, how you can get more data on items offered on the advertising pages, what reprints are available and how you can get them, and what you should know about subscriptions to PETROLEUM PROCESSING.



This Ethyl engineer matches crank angle time with the cylinder pressure pattern on a dual beam oscilloscope.

Ethyl Research Measures True Engine Friction

Unique instrumentation used to study the advantages of high-compression engines and their octane requirements

by R. E. Gish

Technical Service Division, Ethyl Corporation Research Laboratories

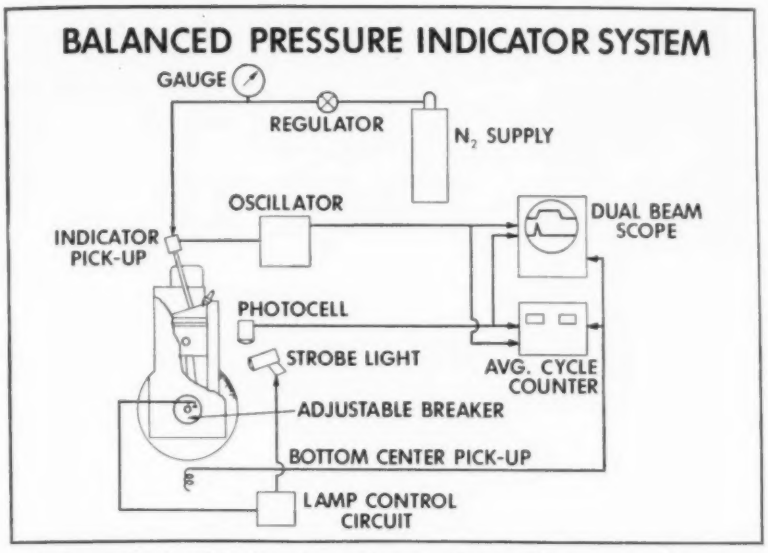
TWO NEW DEVICES for measuring friction in an automobile engine during operation have been developed by Ethyl Corporation's Research Laboratories to improve the accuracy of studies of high-compression engine behavior.

These studies are being conducted as part of a continuing effort to preserve a reasonable relationship between the advantages of high-compression engines and their octane requirements.

The unique instruments make obsolete a method of approximating power-robbing friction losses by measuring the amount of power required to drive a non-firing engine.

This approximation does not take into account the effects of combustion pressures and temperatures which are present only during actual operation. Using the new instruments together, true engine friction can be determined accurately.

(To obtain more data on advertised products see page 230)



A schematic drawing of the electronic measuring system for measuring true engine friction.

Mechanical Efficiency Maintained as Thermal Efficiency Increases

Differences between true and motoring friction were studied in a four cylinder, overhead valve engine at compression ratios of 7.0 to 1 and 12.0 to 1. This engine was selected because attractive gains in power and fuel economy had been obtained with increased compression ratios in a previous test program. These results offered ample evidence of the engine's structural rigidity.

Test results verified that motoring friction does not provide a firm guide to true engine friction; motoring friction was both significantly higher and lower than true friction in the various tests.

Variations in peak cylinder pressure are averaged as the engine runs on this "average cycle counter."

This research program also showed that, although friction increased with compression ratio, the mechanical efficiency of the engine during full-throttle operation was only 1.5% lower at the 12 to 1 compression ratio than at 7 to 1.

Thus, it appears that mechanical efficiency can be maintained almost constant as thermal efficiency increases throughout this compression ratio range.

It was shown, in addition, that certain worthwhile improvements in brake horsepower can be obtained from relatively small increases in mechanical efficiency.

Equally significant, the limiting ratio for improvements in brake horsepower and fuel economy appears to be well above the 12 to 1 ratio as the curve of brake thermal efficiency versus compression ratio shows no sign of leveling off at 12 to 1.

Electronic System Includes New Pressure Measuring Equipment

One of the new instruments is a specially-designed, balanced pressure indicator that compares cylinder pressure with a known reference pressure. The second new device is an "average pressure" computer which averages the cycle-to-cycle variations in pressure in the peak pressure region and establishes the corresponding crank angles.

Both are also used in conjunction with a dual beam oscilloscope and associated electronic equipment to obtain a visual indication of the relation between cylinder pressure and crank angle.

The data obtained permit accurate plotting of the pressure-volume relationships in an operating engine.

Thus, indicated horsepower can be determined directly. Since brake horsepower is measured simultaneously, friction horsepower can be determined by subtraction. (Indicated Horsepower – Brake Horsepower = Friction Horsepower.)

This study is typical of the many ways in which Ethyl uses its unique position as liaison between the Oil and Automotive industries. The underlying purpose of all such long range studies is to help engine designers take maximum advantage of high compression and still hold octane requirement to a reasonable level.

How Ethyl Research is helping you

More than 30 years of intensive fuel and engine research experience and extensive research facilities enable Ethyl to contribute to the progress of both the oil and automotive industries.

The instruments and technique described here are just one product of this experience and these facilities.

As always, our Technical Representatives, backed by the extensive facilities of Ethyl's Research Laboratories, want to share their knowledge with your technical people.

Your Ethyl Representative will welcome the opportunity to arrange an appointment for you.

Send for your free copy of our technical paper entitled, "Determination of True Engine Friction." Address your request to Ethyl Corporation, 100 Park Avenue, New York 17, N. Y.

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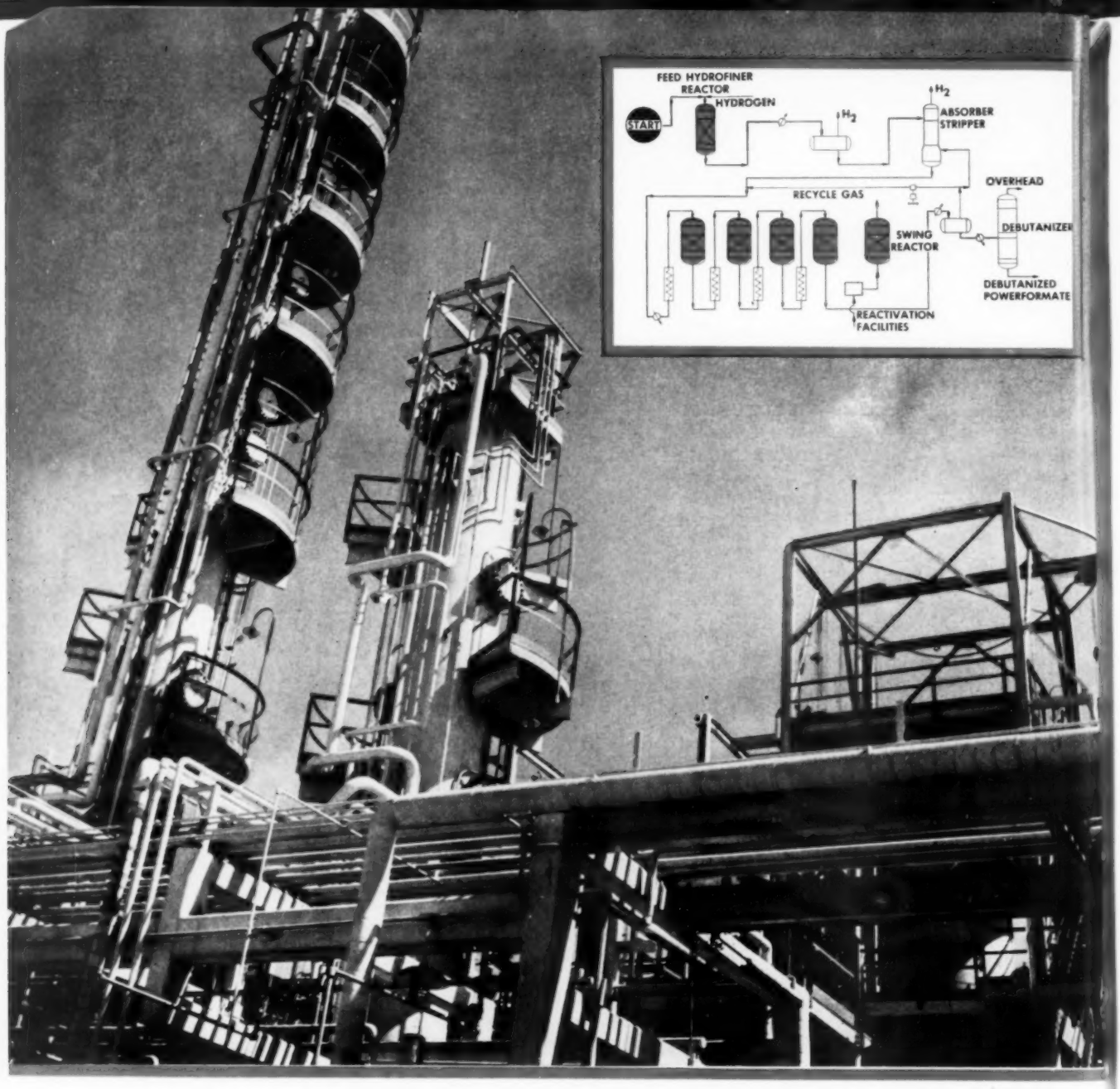

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Esso Research and Engineering Company offers you *Powerforming*, the most versatile platinum reforming process ever developed. *Powerforming* is another achievement of the Esso Research program – 37 years of new process developments which have been made available to refiners around the world.

Heart of the *Powerforming* process is a new, more active platinum catalyst. High activity over a long life is assured by significant new regenerative techniques. With this new process, good yields of 100 octane clear Powerformate can even be obtained from paraffinic stocks. Three *Powerforming* installations are on stream; eighteen are in the planning or construction stage. Licensees enjoy benefits of continuing *Powerforming* research. We would welcome your inquiry on the part *Powerforming* can play in *your* modernization plans.

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Dear Reader...

. . . We're breaking editorial policy in this issue, or at least bending it pretty badly. A long-standing rule of ours holds that "special issues" devoted to a single subject are a mistake, on the grounds that such a single subject is of interest to only a minority of our readers, and that the rest of you are therefore cheated.

But this month we are using all our editorial feature space —72 pages—to bring you the first complete technical story about the world's newest and most modern plant—Tidewater's 130,000 b/d Delaware Refinery. These articles cover every phase of refinery operation and therefore will interest every PETROLEUM PROCESSING reader.

Early in the planning for this issue we decided to use a "saturation attack" on it. We figured that we shouldn't ask Tidewater's technical men to write the articles for us, because they were understandably more concerned with getting their plant into operation. So we said we'd write most of the articles ourselves, and count on the engineering firms for descriptions of the major processing units.

And to minimize the demands we'd have to make on Tidewater people to get the necessary data, we suggested we concentrate all our interviewing in one period.

Accordingly, seven of our editors were put on the job. Each was given from three to six specific assignments, and a coordinated schedule of interviews was worked out for a 2-day period. We began our "invasion" the evening of April 8, with a drive to Delaware from New York City. Promptly at 8 the next morning we walked into the Refinery, were met by R. S. Stanfield, introduced to the men we were to talk with—and went to work. Well into that evening and all of the next day we interviewed, took notes, and wrote up rough drafts of our articles

During the same period—and for a third day as well—two other members of our staff worked with two photographers and took over 150 pictures of various parts of the refinery.

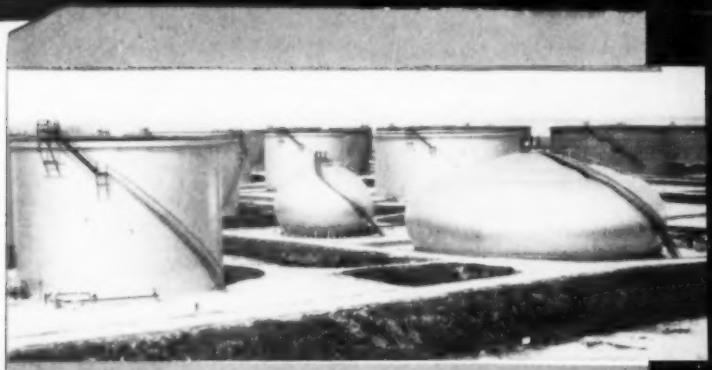
No project of this magnitude can succeed, of course, without cooperation. And we had it. Tidewater literally rolled out the red carpet for our interviews and gave us every possible assistance. C. F. Braun & Co., the major engineering and construction contractor, assigned 22 of its engineers to prepare information memos for us.

And pulling everything together was our own project coordinator—Assistant Editor Willis "Buzz" Bussard. His job was to supervise the operation, arrange interviews, avoid duplications and discrepancies, get clearances, and finally, get it all done on schedule.

He did it—as you'll see starting on p 99.

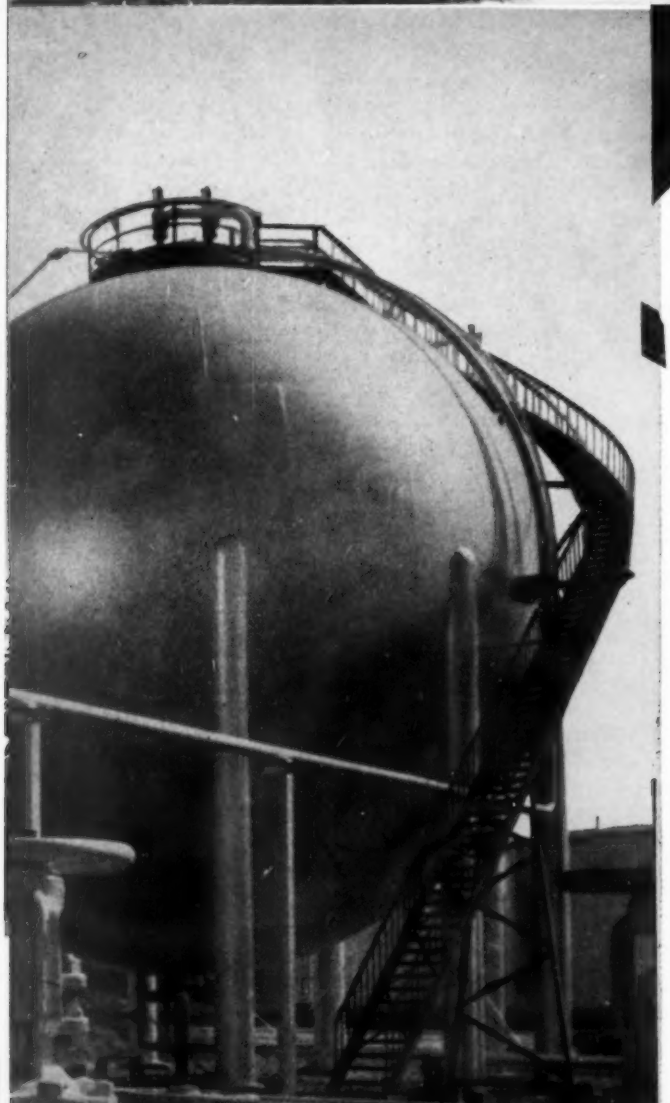
William F. Bland

—Editor



CB&I-built tank farm stores all

7 MILLION BARRELS



...for Tidewater Oil Company's Delaware Refinery

Tidewater Oil Company's new ultra-modern 130,000 barrel per day "Refinery of the Future" is served by one of the largest tank farms ever built by Chicago Bridge & Iron Company.

All crude and petroleum products in the refinery will be stored in the 7-million-barrel tank farm fabricated and erected by CB&I, and furnished through the C. F. Braun Company. This includes: 50 Horton® Floating Roof tanks, 63 Horton Cone Roof tanks, 5 Hortonspheres® and 3 Hortonspheroids®. Also built for "Operation Tidewater" were Horton process structures including reactors, fractionators and drums.

The design, fabrication and erection of petroleum storage and processing equipment is a specialty—and an art, with Chicago Bridge & Iron Company. Write our nearest office for the new bulletin on CB&I *Field Services.*

P-55CBI

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WHAT'S HAPPENING

In refining

... **The Aronow refinery,** near Kalispell, Montana, has been reactivated after being idle four years. The 700-1000 b/d refinery will produce jet engine fuel to the Air Force.

... **Atlas Processing Co.** will build a deisopentanizer and deisohexanizer for its planned Penex isomerization unit. Hudson Engineering Corp. will start the $3-million project this fall for completion by March 1958.

... **Ben Franklin Refining Co.** will build a 1000 b/d hydrofluoric alkylation unit (UOP license) at its Ardmore, Okla., refinery. Construction will be by Refinery Engineering Co.

... **Champlin Oil & Refining Co.** will have Badger Manufacturing Co. build a 1430 b/d, Phillips-process, HF alkylation plant at Champlin's Enid, Okla., refinery. The $1.9-million unit is due on-stream by March, 1958.

... **Commerce Oil Refining Corp.'s** long talked about 30,000 b/d refinery for Rhode Island's Narragansett Bay area is still indefinite. Local residents are objecting to construction of the $45-million plant and Navy Dept, too, "prefers" that it be built elsewhere. Final decision may be made at high levels in Washington, though construction is set to start Sept. 1.

... **Continental Oil Co.** has completed an 11,000 b/d cat reformer and 16,000 b/d desulfurization plant (both by M. W. Kellogg) at its Ponca City, Okla., refinery.

... **Florida refinery plans** for the Jacksonville area reportedly will be announced soon by a refining company.

... **Frontier Refining Co.** plans to expand its Cheyenne, Wyo., refinery up to 22,000 b/d from its present 16,500 b/d capacity. Asphalt capacity will be increased from 5000 b/d up to 10,000 b/d.

... **Gulf Oil Corp.** will build a Penex unit to isomerize pentanes at a yet undesignated site.

... **Gulf Oil Corp.** started full-scale research in its new A. W. Mellon Nuclear Science Laboratory, dedicated late May, at its new research center at Harmorville, Pa. The lab houses a 3-million volt Van de Graaff generator.

... **Oil Investment Co.,** a new organization of Magnolia, Ark., has options to purchase Berry Asphalt Co. for "over $4 million."

... **Pontiac Eastern Corp.'s** Black Creek, Miss., refinery will start coming onstream soon. By fall, the entire 11,000 b/d, $18-million refinery is expected to be operating.

... **L. Sonneborn Sons, Inc.,** have doubled research facilities at its Petrolia, Pa., refinery to extend efforts with white mineral oils, petrolatums, microcrystalline waxes and petroleum sulfonates.

... **Texaco Development Corp.** will add a radiation research lab at its Beacon, N. Y., center. Equipment will include a 6-million-volt linear accelerator, a 3-million-volt Van de Graaff generator, and a 35,000-curie cobalt source, the latter from the Canadian NRX reactor, Chalk River, Ont.

... **The Texas Co.** is increasing crude capacity at its Port Arthur, Texas, refinery by 20,000 b/d to a new total of 80,000 b/d. Fluor Corp., Ltd. is building a new 80,000 b/d crude still to replace existing stills, with completion due by early next year.

In petrochemicals

... **Dow Chemical Co. of Canada, Ltd.** has purchased a 400-acre site at Sarnia, Ontario, Canada, for possible expansion near other Dow petrochemical plants.

... **Du Pont Co.** is preparing to produce Teflon 100-X, a new perfluorocarbon resin with a melt viscosity low enough to permit extrusion. Du Pont hopes to produce the resin in commercial quantities by early 1959 at its Parkersburg, W. Va., plant. Meantime, it will increase by 30% its capacity for the four Teflon resins now produced commercially.

... **Phillips Pacific Co.** has started production of

The demand, stocks, trends picture

	1957 to June 14	1956 All June	% Change
Runs to stills	7.904	8.051	− 1.9
Demand			
Gasoline	4.327	4.126	+ 4.9
Middle dist.	1.230	1.335	− 7.9
Residual	1.404	1.438	− 2.4
Stocks			
Gasoline	191.601	181.032	+ 5.8
Middle dist.	132.958	120.251	+10.6
Residual	42.870	38.575	+11.1

(Figures are in million b/d, API data)

For more details, turn to p. 225, this issue.

anhydrous ammonia (200 t/d) at its new Finley, Wash., plant.

... **Standard Oil Co. of Calif.** will add a second paraxylene unit at its Richmond, Calif., refinery. The $3-million, 25-million lb/yr unit is to be completed early 1958.

... **Texas Butadiene & Chemical Corp.'s** recently dedicated Channelview, Texas, plant is considering diversification into solvents, alcohol, and synthetic rubber raw materials other than butadiene within five years. Isomerization of butane and pentane will probably be first.

In gas liquids recovery

... **Cabot Carbon Co.** will build a $1-million gasoline plant in Lea County, Texas. Initial capacity will be 3.5-million cu ft/d of gas. Plans are for eventual expansion to 6-million cu ft/d. Completion is due late 1957.

... **Humble Oil & Refining Co.** plans a major expansion of Southwest Texas gas operations. The $75-million program includes a large processing and cycling plant, a gathering system, and a pipeline to industrial customers in the Houston-Beaumont, Texas, area.

... **Sunray Mid-Continent Oil Co.** has acquired the oil and gas properties of Arkla Oil Co., Inc., including a gasoline plant located near Rodessa, La., presently processing gas from the area.

In foreign operations

... **Europe**

... **The Austrian Government** wants to build a 50,000 b/d refinery near Schwechat to replace refining capacity lost by Oesterreichische Mineraloel Verwaltung (OeMV, Austrian Government agency managing nationalized part of Austria's oil industry) by return to pre-World War II owners. Plans are to decrease imports.

... **British Petroleum Co. Ltd's** total refining capacity in the United Kingdom will total more than 260,000 b/d in 1959. The 44,000 b/d Grangemouth, Scotland, refinery will be increased by 20,000 in a $12-million plan, and a $73-million expansion at Kent, Great Britain, will increase the refinery's 92,000 b/d capacity to 140,000 b/d by the end of 1957.

... **Esso AG** will start its first major German petrochemical operation in the Cologne area. The $14-million plant will make ethylene, butadiene, and propylene tetramer. Operations are due to start in 1959.

... **European refining and petrochemical** projects underway by Friedrich Uhde GmbH of Dortmund, Germany (design and construction subsidiary for Farbwerke Hoechst AG group's processes) are:

- Hidro Nitro Española, 22 t/d ammonia synthesis at Monzón, Spain, for completion late 1957; 88 t/d ammonium sulfate plant at Tarragona, Spain, for completion late 1957.
- Krupp-Kohle-Chemie, 175 t/d ammonia synthesis and 420 t/d ammonium sulfate plant at Wanne-Eickel, Germany, for completion mid-1957.
- B. P. Benzin und Petroleum GmbH, 5000 b/d gasoline desulfurizer at Hamburg, Germany, for completion by mid-1957.
- ANIC, 320 t/d nitric acid plant in Italy—being engineered.
- Farbwerke Hoechst AG, Hoechst, Germany, 3500 b/d distillation unit for completion mid-1957; propane-propylene separation in planning stages for late 1957; and 11,000 t/yr acetaldehyde plant in planning stages for unspecified date.
- Esso AG, Koeln, Germany, 72,000 b/d refinery in engineering stages by Braun, Uhde and others.
- Destillerie Italiane, Milano, Italy, 11,000 t/yr butanol from acetaldehyde plant in engineering stages.
- Ammoniaco Portugués, Esterreja, Portugal, 40 t/d ammonia synthesis plant and 220 t/d ammonium sulfate plant in design stages for completion in March 1958.

... **Farbenfabriken Bayer** plans an ethylene plant near Dormagen, Germany. The 15,000 t/yr ethylene plant, due onstream in late 1958, will use crude petroleum feedstocks, and will also make propylene, butylene and butadiene.

... **Gottlieb Duttweiler** has founded a company in the North Sea harbor, Emden, Germany, under the name of Erdoelwerke Friesia A.G. to establish a $15-24-million refinery in Emden (PP,6-57,p.10). Backing will be by Duttweiler's Swiss Migro organization, one U. S. and two German companies, and the state of Lower Saxony.

... **Houilleres du Bassin de Lorraine** (H.B.L.) has completed a styrene (from benzene and ethylene) plant at Carling, Alsace, France.

... **International Synthetic Rubber Co.** (Dunlop Rubber, Avon India, Michelin Tire, and the British subsidiaries of Goodyear and Firestone) plant under construction at Hythe, Hampshire, will be completed late 1958 and will make 50,000 long t/yr of GR-S rubber. Blaw-Knox Co. is the builder.

... **Irish Refining Co. Ltd.** has been formed (PP, 6-57,p.12) to process petroleum in County Cork for Esso Petroleum, Shell-Mex, British Petroleum and Caltex. Lummus Co. will build the $30-million, 40,000 b/d refinery for 1959 completion.

Reaching For The Sky But
STILL TIED TO THE GROUND

Reaching for the sky, this modern jet plane is dependent on the nation's refineries to provide the specialized fuel that is needed to get them there. In 1957, for example, it is estimated that jet fuel requirements will increase by approximately 12 per cent.

Increased demand for petroleum products calls for increased efficiency in refinery operations. That's where Hercules Polyrad comes in.

Polyrad, a filming amine that acts as an inhibitor and detergent, helps maintain throughput, increase heat transfer, and cut down time for maintenance. At turn-around time you see the difference that Polyrad makes.

Stocks of Polyrad are maintained at conveniently located points throughout the country and overseas. We'll be glad to discuss the application of Polyrad to your specific operating conditions.

Pine Chemicals Division, Naval Stores Department
HERCULES POWDER COMPANY
INCORPORATED
984 King St., Wilmington 99, Del.

REFINERS RELY ON
POLYRAD®
FILMING AMINE INHIBITOR

(To obtain more data on advertised products see page 230)

What's happening (continued)

. . . **Mobil Oil Co.** has placed a 6000 b/d cat reformer (built by Bechtel International Ltd.) onstream at its Coryton, Britain, refinery.

. . . **Latin America**

. . . **Electro-Cloro** of Sao Paulo, Brazil, will come out with a rigid polyethylene product produced by a Phillips Petroleum Co. process license.

. . . **Petróleos Mexicanos** is ready to build a 15-million lb/yr polyethelene plant at Pemex's Atzcapotzalco refinery. Using Phillips Petroleum's licensed process, completion is due in 1959.

. . . **East**

. . . **Arab News Agency** dispatches reaching London say the Iraq Development Board has approved a loan of about $7 million to the Government oil refinery department for expansion at Qayara.

. . . **British Petroleum's** Kwinana, Australia, refinery has started an $8-million expansion with the addition of 17.5-million Imperial gallons of storage, to be followed by a catalytic reformer.

. . . **Ceylon** will make an early decision on granting a concession for its first refinery. Decision is between an offer by the Shell-B.P.-Caltex-Stanvac group, and an offer by an Indian group claiming backing from National Iranian. Informed circles expect the Shell group to get the concession.

. . . **Idemitsu Kosan Co.'s** new 30,000 b/d refinery at Tokuyama, Japan, is now onstream. The $25-million refinery has a 3000 b/d Platformer, Fluid Catalytic Cracking, Unifining and Unisol units licensed by Universal Oil Products Co.

. . . **Petrochemical projects** underway by Friedrich Uhde GmbH (see Britain & Europe) in the East are:

- Korean Government, Chung-Ju, Korea, urea prilling tower under construction. Uhde Corp. is licensor, Hydrocarbon, McGraw, and Vulcan the engineers, and Hydrocarbon and McGraw the contractors.
- **Taiwan Fertilizer, Ltd.,** Nankong, Formosa, urea prilling tower in construction by staff under Uhde license, with engineering by Hydrocarbon and Vulcan.

. . . **The Soviet Union** has contracted for Friedrich Krupp, of Essen, West Germany, to build a $4-million plant to make synthetic fibers similar to Britain's Terylene. Final West German government approval is expected soon.

. . . **Standard Vacuum Oil Co.** plans to increase the capacity of its Trombay, India, refinery by 5000 b/d up to 33,000 b/d. The five year expansion will cost $10.6 million.

In markets and prices

. . . **Early June pessimism** over Gulf cargo prices for gasoline gave way to optimism in the month as demand showed improvement and refinery cuts in crude runs, and refinery strikes, cut into stocks. But while the cargo market showed improvement for the first time in many months, gasoline was having trouble in other supply centers in holding its price position.

Residual fuels showed general easiness. Spread between ordinary bunker "C" fuel and maximum 1% sulfur material narrowed to 5¢/bbl when the price for low-sulfur grade dipped 25¢/bbl. Trade declared this to be a natural summer phenomenon with some holding the opinion that maximum 1% sulfur material actually might be losing all of its favored winter price position.

Distillate prices tumbled 0.5¢ at the Gulf early in June with net reductions up to 0.4¢ coming later along the East Coast. Interior wholesale markets reflected summer softness in middle-of-the-barrel cuts by dropping 0.125¢ to 0.25¢ with little difficulty.

A number of refiners, meanwhile, because of 6% hikes in union wages and higher refinery costs, began paddling upstream against market conditions by declaring they were advancing clean product prices 0.2¢ and residual fuel by 5¢/bbl. At press time, many question whether such an operation could hold against a tide of products.

Looking ahead

. . . **General Motors** engineers say the automotive gas turbine is "nearly ready" to compete with piston engines in certain commercial and military operations. They term gas turbines "practical and feasible" for heavy-duty and military vehicles with "no additional engineering breakthroughs.

. . . **Shell-Mex and British Petroleum's** Industrial Fuels General Manager, H. Cunliffe, said the oil industry must invest $112 billion in the next ten years to keep up with world needs. This expenditure would cover "new tankers, exploration, new wells, new refineries, and so on." The needed investment "can only be achieved by the oil companies retaining by far the greater part of their earnings and plowing it back into the industry."

. . . **Fluidized solids** as a processing technique may soon be widely used in petrochemicals production. Process design expert Joseph W. Moorman told a WPRA regional meeting recently that, with petrochemical production capacity to be upped sharply in the near future, designers might turn to fluid-type catalysis in new plants rather than invest in converting older plants to the technique. Fluidized solids can be applied to good advantage in any process that requires close temperature control in its reaction system.

LUMMUS

ENGINEERS AND CONSTRUCTORS FOR INDUSTRY

385 Madison Avenue New York 17, N. Y.

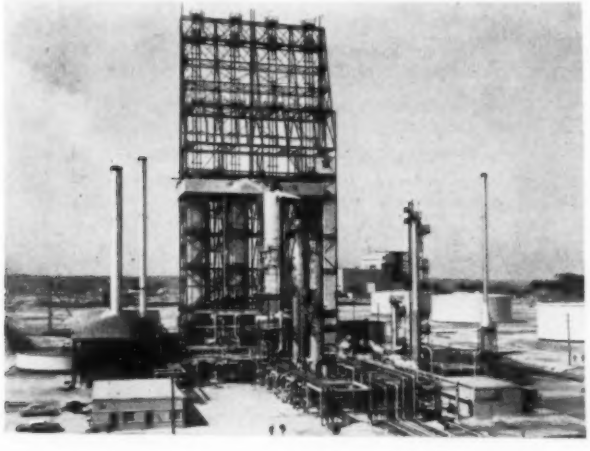
NEW AMOCO DELAYED COKER EXCEEDS EXPECTATIONS...RUNNING MOST DIFFICULT CHARGE STOCK

Lummus designs, engineers and constructs unique 4-coke-drum, 600 ton-per-day unit. Designed for vacuum bottoms containing 25% Conradson Carbon.

A Delayed Coking Unit which handles the heaviest feed ever charged is now in operation at the new Yorktown, Virginia refinery of The American Oil Company.

The unit has been in continuous operation since the initial firing on January 30, 1957, surpassing all guarantees of capacity of charge stock and product specifications, and has been formally accepted before completion of this run.

The fractionating tower produces light and heavy gasoline and light and heavy gas oils meeting all rigid Amoco specifications for the production of high octane unleaded gasoline. Coke produced meets client's specifications for pulverizing for use in boilers.



This delayed coker at Amoco's new Yorktown, Va. refinery handles the heaviest charge on record. Four coke drums measure 17'6" x 75' tangent to tangent. Refinery will help supply unleaded "Amoco-Gas" to an 18-state market.

Evaluation of charge stock in Lummus laboratories and pilot plants supplied the information for special design features that were incorporated into the heater—the heart of the process—and other critical equipment, to handle the heaviest charge stock on record. The unit was designed for a charge mixture of vacuum reduced crude with 25% Conradson Carbon, an API gravity of 6.1°, and an SFS viscosity of 6,000 at 210° F. It was also designed to process a variety of stocks at different recycle ratios to meet required flexibility.

The new unit, based on pilot plant work at Lummus laboratories, was designed, engineered and built by The Lummus Company, and was completed 10½ months after the piles were driven.

Lummus has designed much of America's coking capacity — 10 units — combined capacity of over 120,000 barrels per day.

Lummus engineers will be glad to show you how your next project can be designed to produce a maximum return on your capital investment.

THE LUMMUS COMPANY, 385 Madison Ave., New York 17, N.Y. *Engineering and Sales Offices and Subsidiaries:* New York, Houston, Montreal, London, Paris, The Hague, Bombay. *Sales Offices:* Chicago, Caracas. *Heat Exchanger Plant:* Honesdale, Pa. *Engineering Center:* Newark, N. J.

(To obtain more data on advertised products see page 230)

November, 1912 NATIONAL PETROLEUM NEWS 33

STEEL TANKS and PLATE WORK

"GRAVER TANKS"

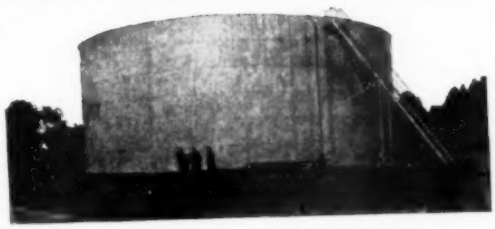
NEED NO INTRODUCTION TO THE

"Independent Dealer"

AS THEY HAVE BEEN

"Favorably Known"

EVER SINCE THE DISCOVERY OF OIL



Large Oil Storage Tank—All Steel Construction

We are carrying in stock, for prompt
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of from 12,000 to 20,000 gallons ca-
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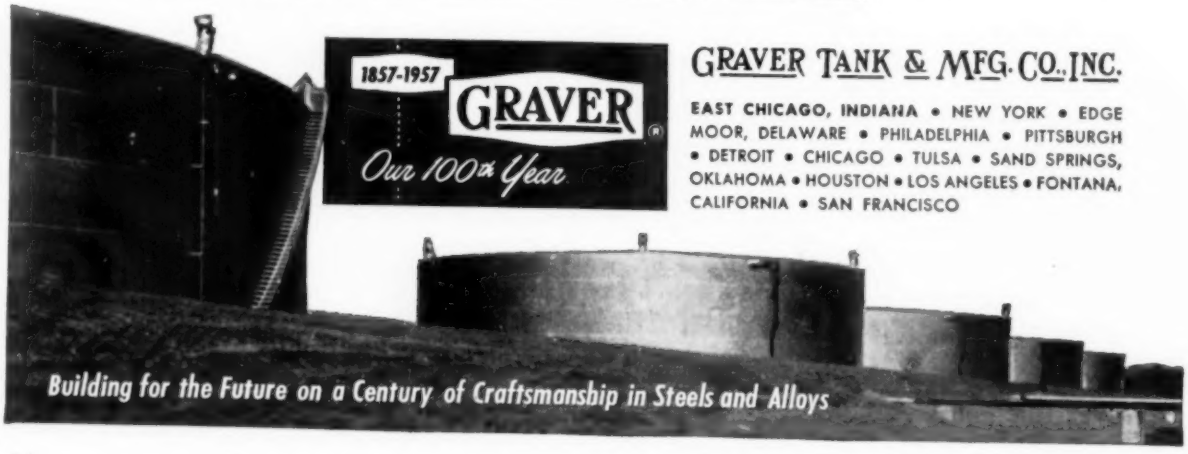
SALT LA 523 Newhou

Long Before There Was an API Code . . .

. . . cone roof tanks built by Graver always met the exacting quality standards rigidly insisted upon by William Graver, Sr., from the time he first began building tanks in 1857.

Over the years, many of the improvements in cone roof tank design and in fabrication and erection techniques were originated by Graver to meet the demand for larger tanks in a variety of shapes.

As Graver begins its second century, traditional Graver quality standards continue to be preferred by buyers of cone roof tanks seeking long life and trouble-free maintenance.



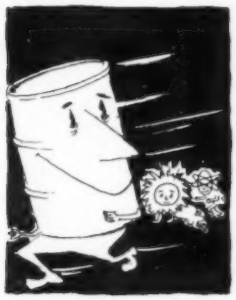
GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA • NEW YORK • EDGE MOOR, DELAWARE • PHILADELPHIA • PITTSBURGH • DETROIT • CHICAGO • TULSA • SAND SPRINGS, OKLAHOMA • HOUSTON • LOS ANGELES • FONTANA, CALIFORNIA • SAN FRANCISCO

 (To obtain more data on advertised products see page 230)

Fossil fuels seen continuing as important energy sources

NEITHER nuclear power nor solar energy is going to be of any significant consequence in this nation's total energy demands for the immediate future. This is the nub of predictions by at least one authority, Wallace R. Brode, associate director of the National Bureau of Standards, who discussed these points at a meeting of the Chemical Market Research Association in May in New York City.



Neither of these energy sources will form an immediate solution to any possible serious depletions of the fossil fuels, Dr. Brode added.

For the longer range future, he said, "We may expect by the year 2000 that nuclear and converted solar energy in use will contribute about 10% of our then total energy requirement and will essentially offset the expected reduction in petroleum energy supply."

Today's sources of commercial energy are about 40% from coal and 50% from fuel oil and gas, he stated. In all, about 90% of the total energy source can be described as fossil fuel. The remaining 10% is divided between wood and water power. From the aspect of conversion into some form of energy, about 12% is electrical, 34% is combustion engines, and 50% space heating and thermal.

If any impact is to be made in fuel conservation, it will be largely through: 1—chemical applications to more efficient usage, 2—thermal insulation, 3—conversion of coal to liquid fuels, and 4—new forms of energy storage by chemical reactions.

Although Dr. Brode's remarks merely touched on some aspects of the future energy picture concerning petroleum, some trend implications seem clear from the above four points. Efficiency in the recovery, conversion, and usage of fossil fuels will continue to be one of the larger questions for which petroleum and natural gas technologists will be seeking a satisfactory answer for many years to come. —W.C.U.

Better fluorine plastics may result from current studies

NEW and better fluorine-containing plastic may soon extend the range of usefulness of this already versatile family of materials. Researchers at the Engineering and Industrial Experiment Station of the University of Florida, in a program sponsored by the Office of Naval Research, are working hard to develop compounds that will remain stable at temperatures up to 1000° F.

This is a pleasant, though perhaps distant, prospect for petroleum processing men—refiners and petrochemical plant men alike. Engineers in our industry have found some of the present fluorine plastics, such as Teflon and Kel-F, to be almost-perfect answers to many containment problems. Extreme resistance to chemical attack, flexibility at low temperatures, and non-adhesive properties of these materials have resulted in their wide-spread use as almost maintenance-free gaskets, mechanical packing, and regulating valve packing.

The big problem, however, has been that the top temperatures the materials can withstand are about 400 to 500° F., which is too low for many applications in today's petroleum processing technology.

Goal of the Florida research program: compounds that will retain stability up to 1000° F, resist corrosion, and retain flexibility at low temperatures. One compound has already been turned up that is stable at 700° F, and others are now being studied.

Although usage is relatively small for these materials in refineries and petrochemical plants, the types of jobs they can perform are highly important. Significant improvements in the upper temperature limits for newer materials should easily result in welcome new tools for chipping away at the high cost of maintenance. —R.E.C.

Plastics in home building loom large on future horizon

WHAT will the home of tomorrow be like? What kinds of materials will be used in its construction? What part will plastic materials play?

Though answers right now are difficult, if not actually impossible, one large manufacturer, Monsanto Chemical Co., has already come up with some interesting figures.

In addition, this company last month launched an intriguing new project, the "House of the Future," at Disneyland, Calif. By exposure of this unusually designed and constructed residence to a large cross section of America, Monsanto and other firms hope to discover facts difficult to obtain in any other way. Associated with Monsanto in this work are such companies as American Telephone

and Telegraph, Armstrong Cork, Chemstrand, Crane, Kelvinator, Mobay Chemical, Sylvania.

This program is aimed at satisfying the functional design precepts of home construction, but by using the inherent properties of plastics in new ways. Quite often these represent a sharp break with traditional design, or at least an acceleration of design trends into new areas. Some ideas may not even be possible or feasible with today's plastics and equipment, but they could be possible at some date in the future. These are the questions the House of the Future may answer.

Even without relying on the impact of new applications for plastics, predictions show impressive growth potentials of plastic usage in construction—in dollar value, about 15% per year, according to Monsanto's M.F.X. Gigliotti in a talk at the annual meeting of the Chemical Market Research Association in New York in May.

At this rate, Mr. Gigliotti said, "in 1966 we could expect a plastics in construction potential of about 10% of all building materials, or about $2-billion." This is 3½ times the present ratio, and the dollar total is roughly equal to today's annual sales level of the entire plastics industry.

What kinds of jobs can plastics do? Many present structural applications give a good indication of what is coming:

- Combinations with other materials. Examples include resin impregnation of wood, lamination of glass and impregnation of textile fabrics.
- Membrane waterproofing—vapor barriers for thermal insulation, etc.
- Insulation—such as film-supported foils and foamed plastics.
- Roofing, gaskets, and sealants.
- Lightweight panels. Plastic sandwich panels for walls, partitions, and roof sections, ideally suited for factory assembly or prefabrication.
- Illumination control panels. Light can be transmitted and controlled in new ways with lightweight and shatterproof plastic sheets.
- Utilities and services. Water, gas, heating, ventilating, and electrical systems, some of the costliest items in building, can be made of plastics. Future sinks, bathtubs, lavatories, and water closets might be molded in modular units, including wall and floor sections. Entire utility cores molded in one piece may become commonplace.

A still further possibility is the chance to avoid limitations of the past by different fundamental approaches. Just one example would be the use of plastic adhesives in place of fasteners and joints.

Two problems still can hinder progress. And Monsanto, along with many others, is directing its activities to solving these two: 1—a lack of awareness among engineers and designers of what plastics are available and what they can do, and 2—confusing terminology or language difficulties—that is, potential users do not understand the language of the plastics industry, and the industry in turn does not understand the language of the engineer and the designer. —W.C.U.

Will we fight fire, radioactivity by remote control tomorrow?

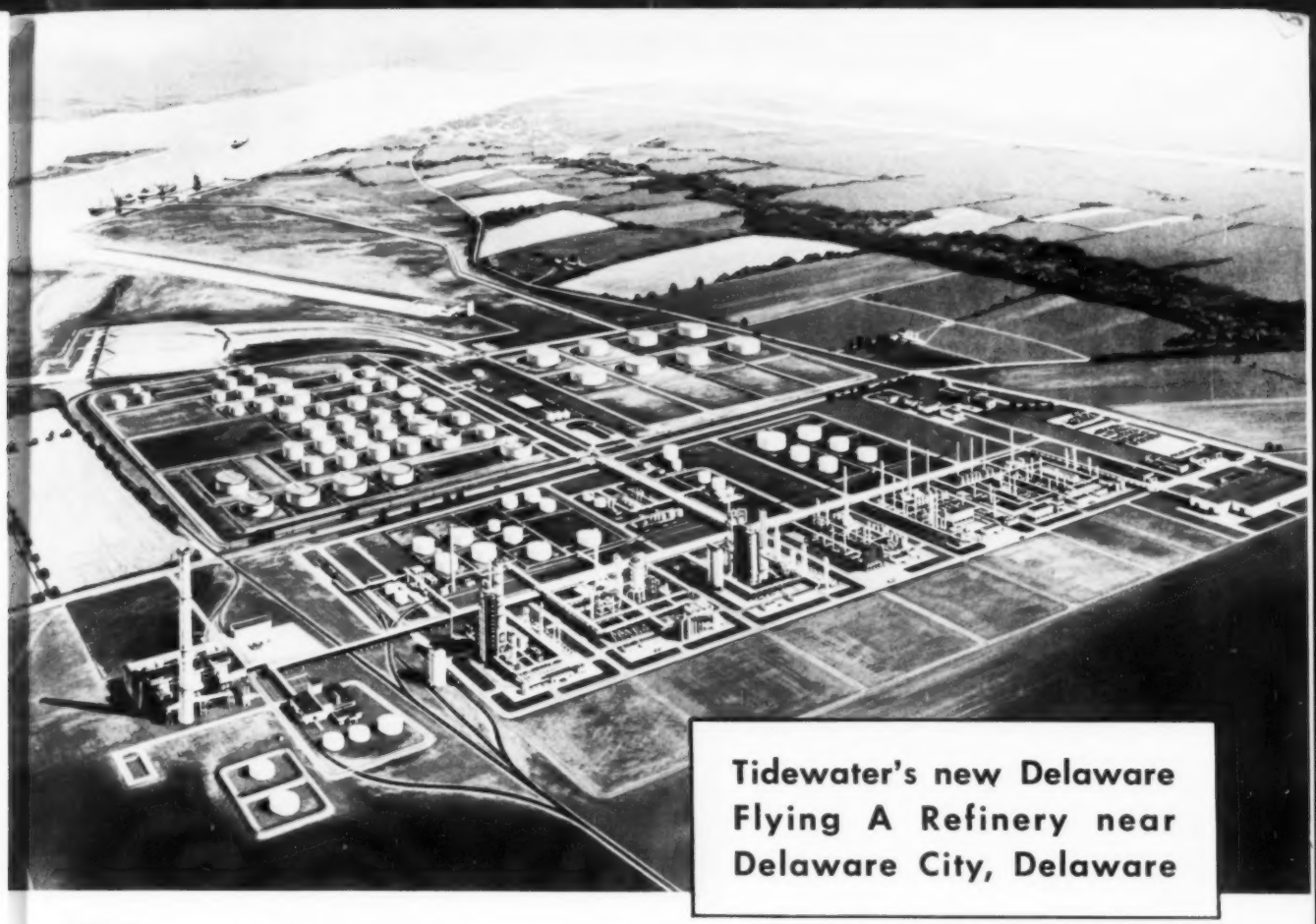
THAT is one of the promises for tomorrow if tests under way by the Army at Fort Belvoir are completely successful. It may be possible to fight storage tank fires at distances up to 15 miles by using a radio-controlled bulldozer. Or, the same equipment can be used for containing escaping radioactive material from tomorrow's petroleum refinery, run by nuclear energy.

At its research and development laboratories at Fort Belvoir, Va., the army has been testing a system that it plans to use for tough construction work in radio-activated areas, or for fighting large fuel storage fires. From a jeep or helicopter equipped with a standard military transmitter and special control box, an operator can start or stop a bulldozer. Gears can be engaged or disengaged, the dozer moved forward and backward, the blade moved up or down, and the steering controlled.

By manipulating the buttons on the control box, a man several miles away can use the tractor for containing spreading oil fires or covering up radioactive material.

As another aid, the Army is considering the installation of a small television receiver on the tractor so that close-up conditions can be "seen." This would be a real aid if smoke completely obscured the fire from a distance, or if a helicopter couldn't close in. —W.A.B

Tomorrow's communications industry will use more plastics. Bell Telephone Laboratories researchers see polyethylene usage as large as that for metals in a few years—as a cable sheath and as an electrical insulant. Strong runners-up will be polyvinyl chloride and neoprene. Other plastics the telephone people like include cellulose acetobutyrate and cellulose acetopropionate for handsets. Today CAB usage is 6 to 7-billion lb annually and the propionate is challenging the butyrate because it lacks odor. —A.C.



Tidewater's new Delaware Flying A Refinery near Delaware City, Delaware

Electricity... instead of steam... powers most of refinery processing equipment

Unique electrical distribution system provides outstanding power continuity

Tidewater Oil Company's new 130,000-barrel-per-day Delaware Flying A Refinery in Delaware, designed and constructed by C. F. Braun & Co., is of special interest because of the high degree of dependence placed on the electrical distribution system. This is especially significant since it is the world's most modern refinery, with the largest initial capacity of any refinery yet built.

With continuity of power a "must"—for even a power failure of a few seconds cannot be tolerated—the problem was to work out systems and components which would set a new high in continuity of operation.

In doing this, certain motors were modified for 250% breakdown torque at normal voltage to meet the special requirements for reacceleration after a fault. It was then necessary to design the control with low drop-out characteristics.

This meant the closest type of relationship was required between all the Allis-Chalmers engineering departments concerned, and C. F. Braun & Co., prime contractors for the tremendous project.

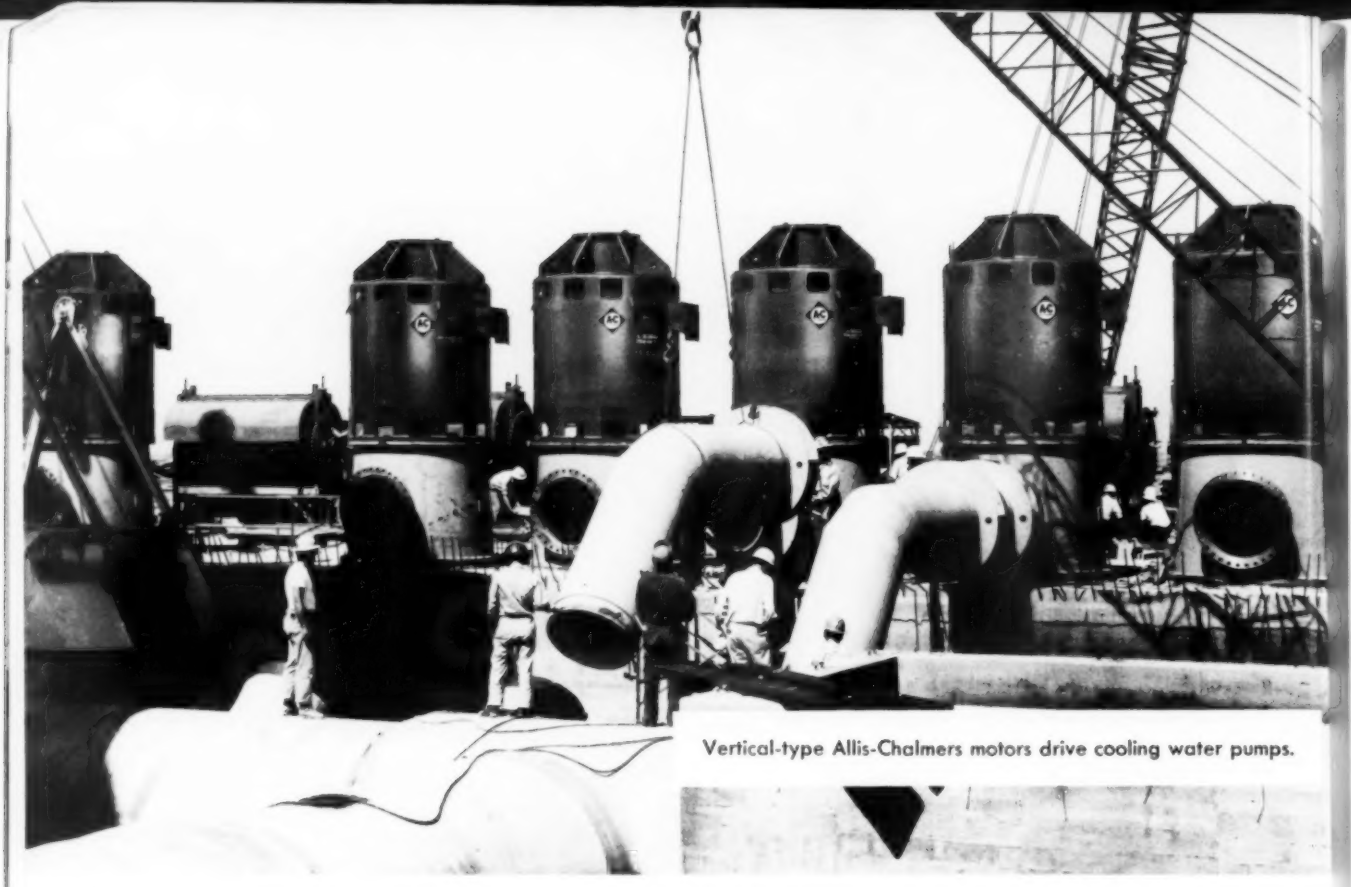
As on other complex jobs, group effort was used to provide coordination between departments, and to take advantage of the variety of experience in each department. Conference phone calls were used to handle matters of delivery and design modifications that came up during construction. In this way, problems could be considered quickly and decisions made immediately.

A network analyzer was used extensively to study the effect on the system of the worst possible faults, thus saving months and months of calculations.

Experience and coordination like this is available to you on applications involving Allis-Chalmers broad line of electrical equipment. Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

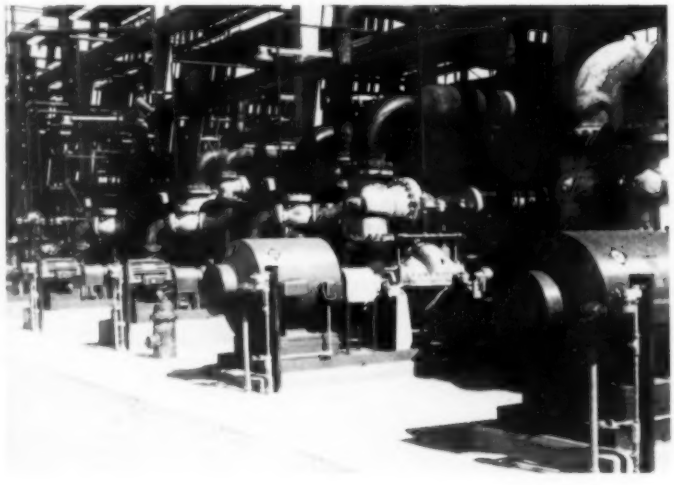
ALLIS-CHALMERS

A-5247

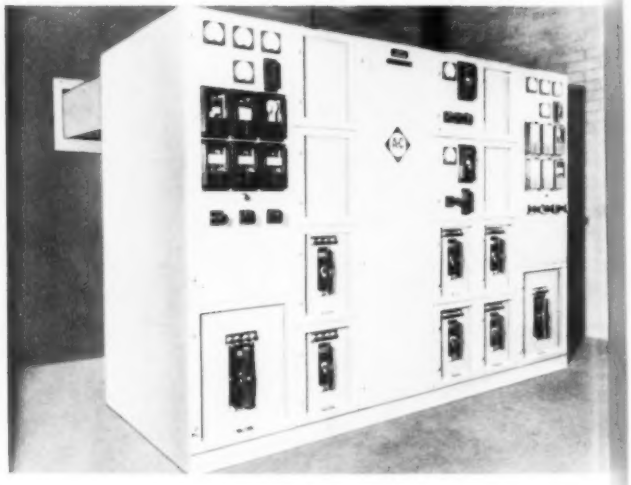


Vertical-type Allis-Chalmers motors drive cooling water pumps.

Electricity at work throughout

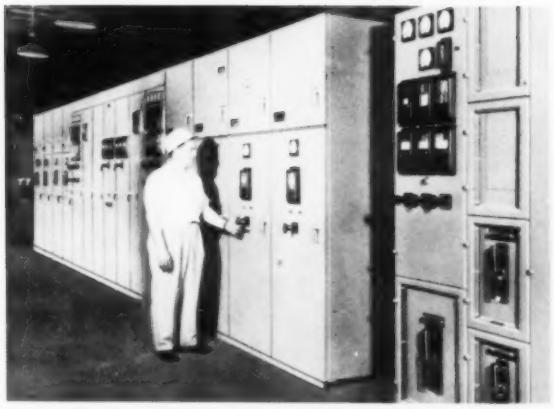


A few of the 300 Allis-Chalmers motors used for driving pumps, compressors and other equipment. Motors in foreground feature tube-type, air-to-air heat exchanger.



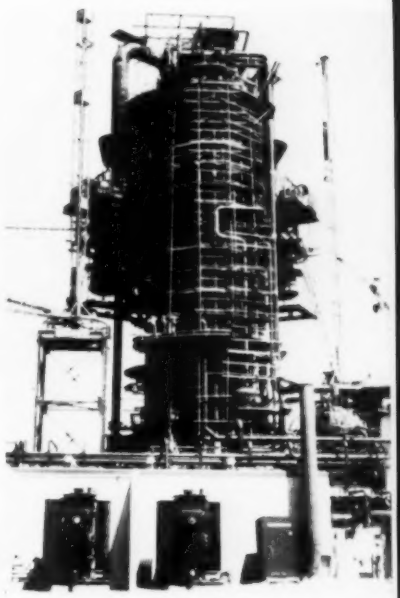
Allis-Chalmers new low voltage switchgear incorporates selective trip, an absolute requirement on the job, in addition to its many other features.

ALLIS-CHALMERS



All the motor control and switchgear are located inside switch houses. These buildings are pressurized to exclude explosion vapors. Bus duct systems are pressurized.

Teamwork! A part of the Allis-Chalmers coordinating team is shown during one of frequent meetings.



All transformers are oil-insulated, sealed-tank construction with welded-on tubular radiators. They are equipped with high voltage disconnecting switches, capable of breaking magnetizing current. Fan motors are explosion-proof.

Tidewater's New Refinery

A few of the 102 Allis-Chalmers high voltage switchgear units for Tidewater's Delaware Flying A Refinery.

More than 125 high voltage motor controllers are used at the new Delaware Flying A Refinery.

Motor Control is one of the Key Factors in assuring Power Continuity

To permit motors to remain on the line through severe system voltage disturbances, important design developments were made in both the 2300-volt motor control circuits and main motor starting contactors.

The magnetic circuit of the high voltage air contactor was redesigned so that it would remain closed, even though magnetically held, for a period of 19 cycles after complete loss of power. In addition, the magnetic circuit remains sealed even when the voltage drops to 35% of normal.

Get details! These developments are important wherever continuity of operation is vital. Allis-Chalmers engineers can help you. Call your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

Two separate studies were made using a network analyzer. Teams from Allis-Chalmers and C. F. Braun & Co. worked together to assure power continuity.

ALLIS-CHALMERS

One of 7 Austin-Western hydraulic cranes at Tidewater Oil Company's new Delaware City refinery shown hoisting a section of pipe at a catalytic cracking unit.

AUSTIN-WESTERN HYDRAULIC CRANE

One of Tidewater's most versatile construction and maintenance tools

Thirty-six Austin-Western hydraulic cranes helped build Tidewater's giant refinery near Delaware City, Del., and seven are now steadily employed handling materials and speeding repairs. They are among the most versatile construction and maintenance tools Tidewater has, and new jobs are being found for them every day.

Here are some of the ways Austin-Westerns save time and money on refinery operations: they remove heat exchanger heads and tubes quickly, eliminating the need for a larger crane or chain blocks; lift and transport pumps into the machine shop for repairs, spotting them precisely; unload freight cars, using their long, live booms fast and efficiently; transport materials with ease under lines in pump alleys and around pumphouses, over railroad tracks, in and out of buildings.

Find out how the flexible Austin-Western hydraulic crane can help you. See your nearby distributor or write direct.

Power graders • Motor sweepers • Road rollers • Hydraulic cranes

BALDWIN BLH LIMA-HAMILTON

AUSTIN-WESTERN WORKS
BALDWIN-LIMA-HAMILTON
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AURORA, ILLINOIS

...for straight right-angle cuts every time...the new

RIDGID

Wide-Roll Pipe Cutter

fast true pipe cuts on your power drive

Rolls are twice the usual width, double the bearing surface on pipe—sure straight start of cut . . . by hand or power drive—extra fast and easy. Pays you to see it before you buy your next cutter—at your Supply House.

No. 201, ⅛" to 1¼"
No. 202, ¼" to 2"

The Ridge Tool Company, Elyria, Ohio, U.S.A.

RIDGID

Work-Saver Pipe Tools

(To obtain more data on advertised products see page 230)

LETTERS

Desalting material

To The Editor: . . . I'd like to call your attention to what is an evident oversight on the part of your editors. On page 145 of the May issue in the Refining Process Glossary, you carry a section on "Chemical Desalting." In this section, you list Tretolite and Visco as sources of chemical desalting compounds. There is, however, no mention of Aquaness as a source of these materials—which are the subject of the Aquaness advertisement in that same issue.

H. M. Parshall

Aitkin-Kynett Co.
Philadelphia, Pa.

● *Reader Parshall refers to the advertisement by Atlas Powder Co., Aquaness Dept., p. 47, May '57, discussing a desalting compound inadvertently omitted from the Process Glossary.*

Wants reprints

To The Editor: I have just finished reviewing the very fine article on Fluor's model shop operations in the April issue of PETROLEUM PROCESSING ("It Pays to Build Design Models," pp 90-96). The entire presentation is extremely well done. We at Fluor honestly believe it is the best and most effective coverage of this phase of our work yet to appear in print. Mr. Willis A. Bussard is to be congratulated.

In a day or so, we will be communicating with you to order reprints. We are certain that this particular article will be in great demand. It is authoritative and thoroughly covers the subject in easy-to-understand terms.

William R. Walker

Supervisor of Public Relations
The Fluor Corp.
Los Angeles, Calif.

Tattered and torn

To The Editor: This reader has been led to understand that editors are good listeners, good sounding boards, and frequently helpful ("Dear Reader . . ." Mar '57 PP, p. 7).

She would, therefore, take keyboard in hand to write a letter of mild complaint, to wit: March issue PP ar-

rived today, Tuesday, Mar. 26. Mr. Herndon, the mailman, who has six children including triplets, brought it at approximately 9:46:10 a.m. Now, isn't this a little late? (In the month for PP, that is, not for Mr. Herndon.) When was this issued mailed?

Moreover, Dear Editor, I enclose the wrapper *as the magazine arrived.* Pet. Proc., like June, was bustin' out all over; the spine was fractured and the pages tattered 'n torn 'n dog-eared 'n dirty.

Needless to say in no wise is the excellent quality of content impaired; our grievance stems from having to wait for April to arrive (almost) to see the March issue, and having the book appear on the scene looking as though it had been detoured through low-finned exchanger tubing enroute.

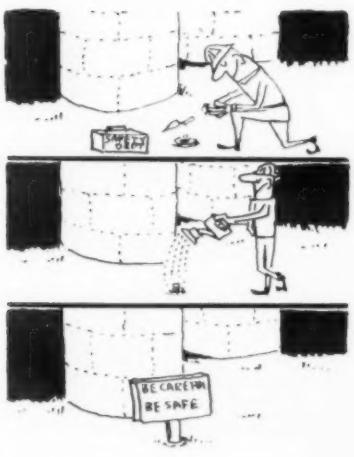
And that, sir, has spoken our piece. Thought you'd not *like* to know the situation, but want to be aware of it. As you've cogently quoted, complaints do move readers to writing letters! And nobody but nobody has the best interests of her old alma mater more at heart than. . .

GWms

McGraw-Hill Book Co.
Charlottesville, Va.

• *Reader GWms (short for Gwynne Williams) until last December was on the editorial staff of PP. She has been advised (1) that shortly after she left the mailing date of PP was changed to the 14th of the month of issue (but that 12 days for delivery is still too long), and (2) that no magazine should arrive in the condition she describes. Do other readers have similar complaints?—The Editors.*

• • •



...No Equal for Quick Pipe Threading

...these handy efficient

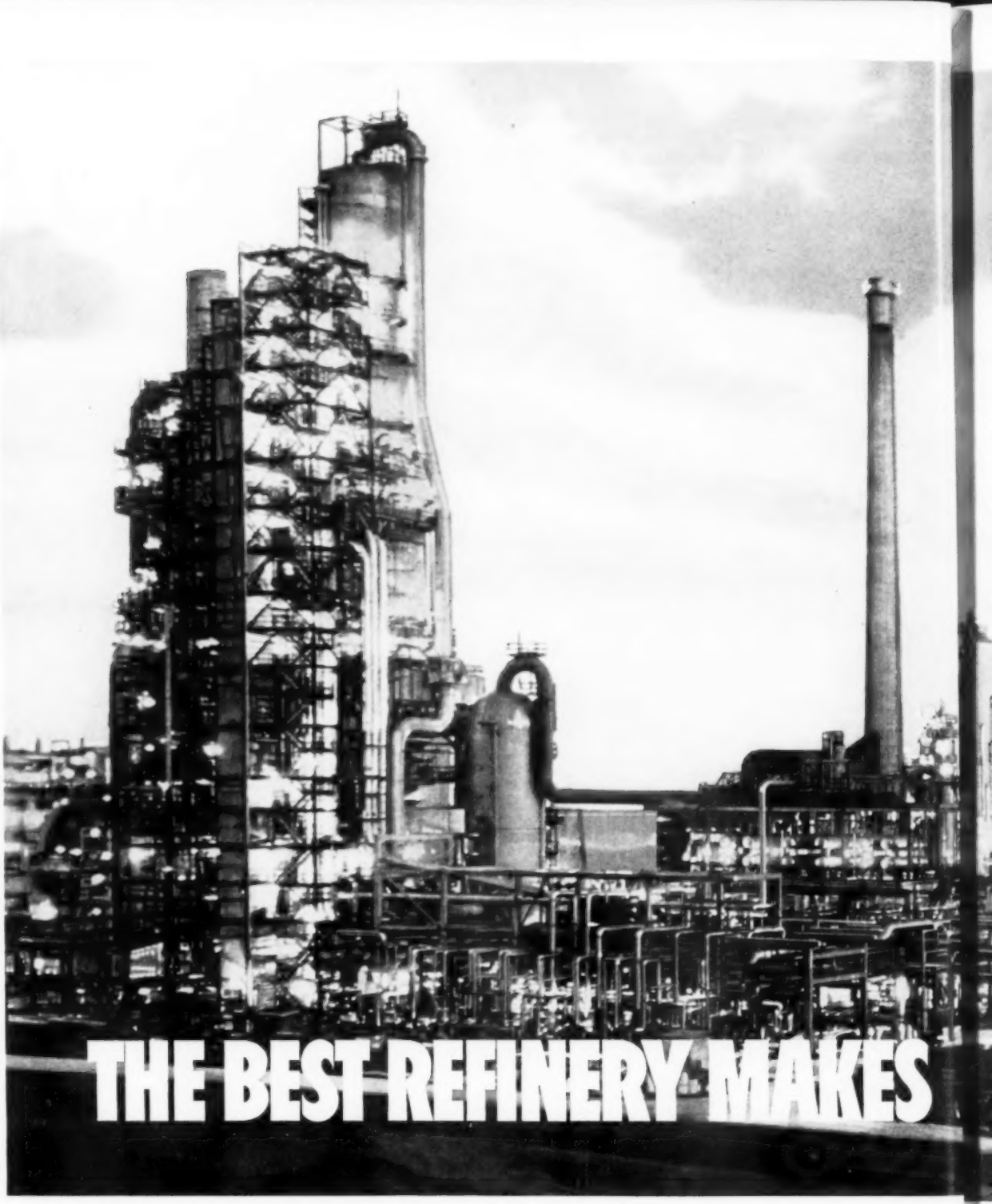
RIDGID
Drop-Head Dies

A die head for each size, ⅛" to 2"—they snap into ratchet ring from either side, can't fall out—reverse for close threads. Tough malleable and steel heads, famous RIDGID long-wear dies—conduit or special dies available. OOR and OR, ⅛" to 1"; 111R and 11R, ⅛" to 1¼"; 12R, ⅛" to 2". Bargains in fast easy threading—at your Supply House.

The Ridge Tool Company • Elyria, Ohio, U. S. A.

RIDGID
Work-Saver Pipe Tools

(To obtain more data on advertised products see page 230)



TIDEWATER'S ALL-NEW DELAWARE REFINERY IS THE BEST . . . FOR SIZE AND SCIENCE!

Starting now, your car can take its power straight from the world's largest all-new refinery. Starting now, you can command the science of the future . . . for this refinery opens up today the era of the 1960's and 1970's. This is the only refinery capable of making its entire gasoline output 100 octane plus. Never before has a refinery been planned on so vast

(To obtain more data on advertised products see page 230)

Tidewater's new $200 million Delaware Refinery occupies the largest industrial site in the East—5,000 acres. It has the world's largest crude unit, fluid coker, catalytic cracker and reformer, extraction plant and hydrodesulfurizers.
FLYING
A
SERVICE
THE BEST GASOLINE

a scale. The result is a gasoline that is not just improved but all new . . . the best!

TIDEWATER OIL COMPANY

SAN FRANCISCO • NEW YORK

NEW FLYING "A" SUPER-EXTRA . . . 100 OCTANE PLUS . . . an entirely new fuel for the highest compression cars of today and tomorrow, at competitive prices.

NEW FLYING "A" GASOLINE . . . new high-octane long-mileage gasoline at regular prices.

CUSTODIS CHIMNEYS ARE A PART OF TIDEWATER'S "REFINERY OF THE FUTURE"

Part of the new Delaware Refinery of Tidewater Oil Company showing 4 of the 11 chimneys constructed by Custodis Construction Co., Inc.

Custodis is proud to have been called upon to construct 11 chimneys for Tidewater Oil Company's new Delaware Refinery

These chimneys, all of reinforced concrete, were constructed to serve both power house and process furnaces. They range in size from 175 feet high with an internal top diameter of 5 feet, to 500 feet in height with an internal top diameter of 20 feet.

Custodis is America's oldest company specializing in chimney construction and has, since 1898, built more than 10,000 chimneys, including the world's tallest. With this outstanding experience, we can design and build chimneys for any specified requirements of modern industry. We are also specialists in the maintenance and repair of chimneys, and in the alteration of chimneys outdated by changes in plant requirements.

If you are currently considering expansion or new plant construction, call on Custodis' experienced engineers to solve your chimney problems. We will be happy to consult with you concerning your requirements, and stand by to offer our services where needed.

OVER HALF A CENTURY OF INDUSTRIAL CHIMNEY PROGRESS

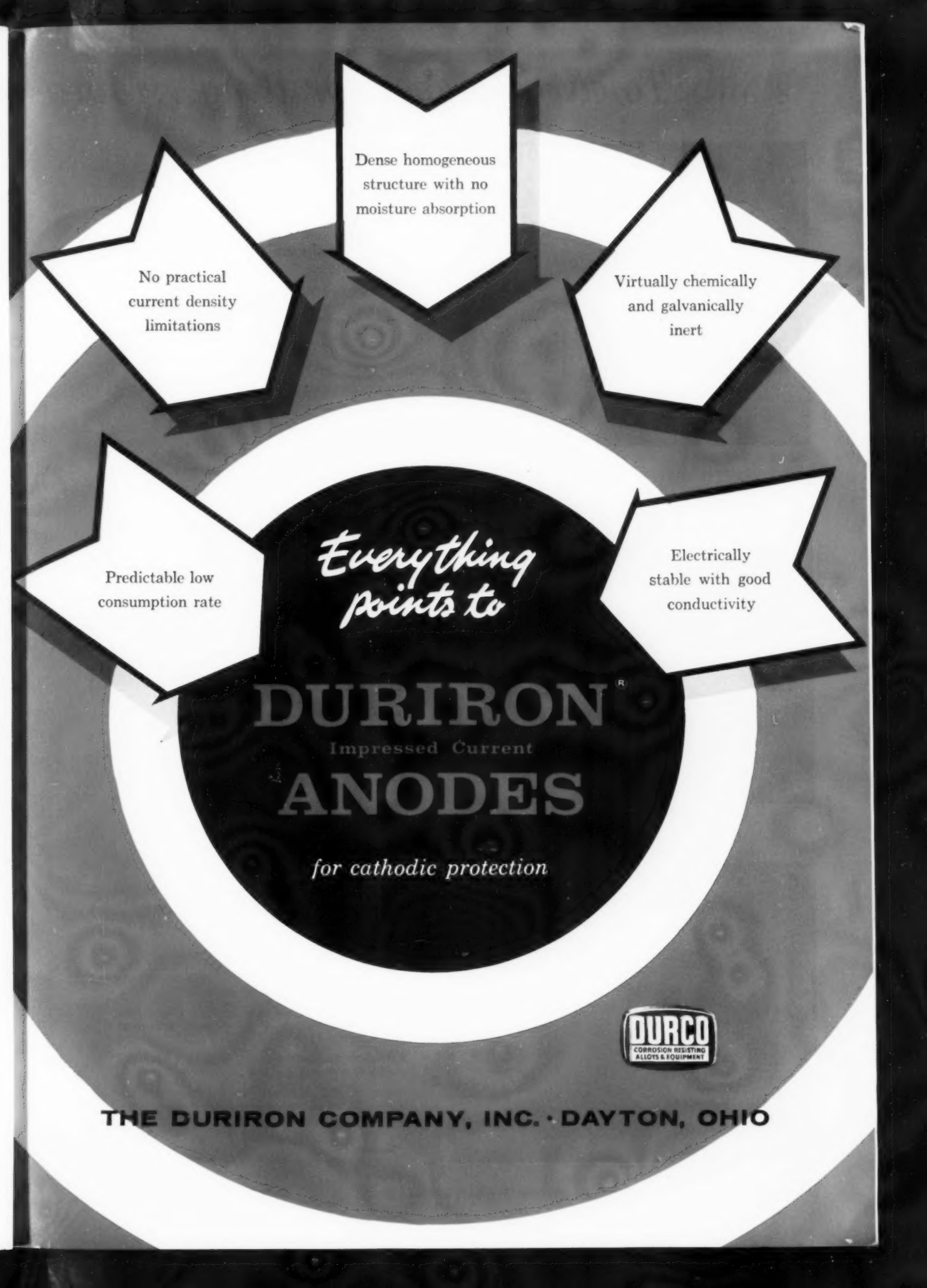
CUSTODIS CONSTRUCTION COMPANY, Inc.

General Office: 157 Chambers Street New York 7, N.Y.

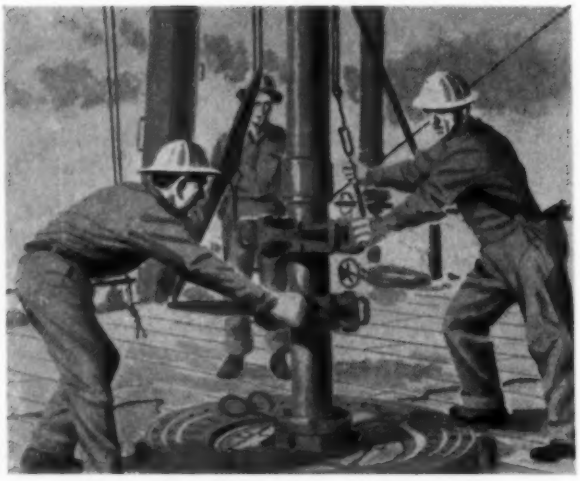
Branch Office: 22 West Monroe Street Chicago 3, Ill.

Sales Offices in principal cities

CUSTODIS CANADIAN CHIMNEY COMPANY, Ltd. TORONTO, CANADA

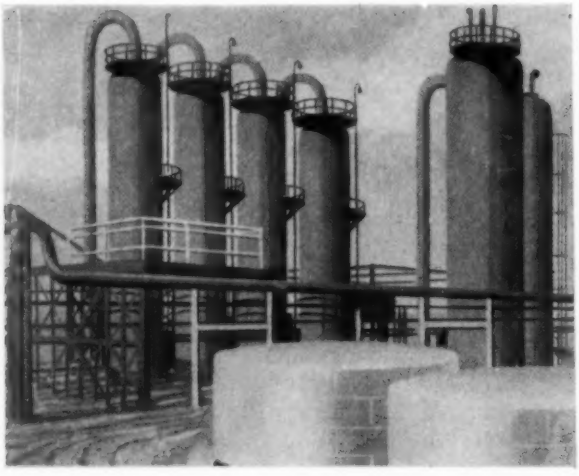

Dense homogeneous structure with no moisture absorption
No practical current density limitations
Virtually chemically and galvanically inert
Everything points to
Predictable low consumption rate
Electrically stable with good conductivity
DURIRON®
Impressed Current
ANODES
for cathodic protection
DURCO
CORROSION RESISTING ALLOYS & EQUIPMENT
THE DURIRON COMPANY, INC. · DAYTON, OHIO

Toward Deeper Drilling...More



RUGGED MUD CONDITIONERS THAT BENEFIT FROM NEW CYANAMID RESIN AND POLYMER DEVELOPMENTS

CYPAN* Drilling Mud Conditioner . . . a high molecular weight acrylic polymer for dependable water loss control.



PROVED HIGH-PERFORMANCE CATALYSTS THAT ARE PRETESTED IN OPERATING REFINERIES

Cracking

AEROCAT® Fluid Cracking Catalysts . . . microspheroidal catalysts, both 13% and 25% alumina types, available in several ranges of particle size distribution.

Reforming

AEROFORM® PHF Platinum Reforming Catalysts . . . platinum promoted alumina base

AEROFORM® MS-1 Fluid Hydroforming Catalysts . . . a spray-dried microspheroidal molybdena-alumina.

Desulfurization

AERO* HDS Catalyst . . . an extruded cobalt-molybdena for sulfur and nitrogen reduction in conjunction with hydrogenation.

Ammonia and Hydrogen Production

AERO* Catalyst FM-2 for ammonia synthesis reaction.

AERO* Catalyst HI-3 for water-gas shift reaction.

AERO* Catalyst NR-1 and NR-2 for reforming methane, ethane or natural gas.

STABLE, HARD-WORKING ANTIOXIDANTS AND LUBE ADDITIVES THAT GIVE NEW LIFE SPANS TO FUELS, MOTOR OILS

AEROLUBE® Lubricating Oil Additives . . . in a wide formulation range for inhibitor-detergency action in all types of crankcase oils.

AEROLUBE® 93-C . . . a concentrated zinc dithiophosphate inhibitor with superior anti-wear characteristics.

AERONOX* Antioxidant 153 and 9010 . . . hindered phenol type for oils, greases and fuels.

AERONOX* MB Methane Base Antioxidant Inhibitor . . . an antioxidant and metal deactivator for special lubricants.

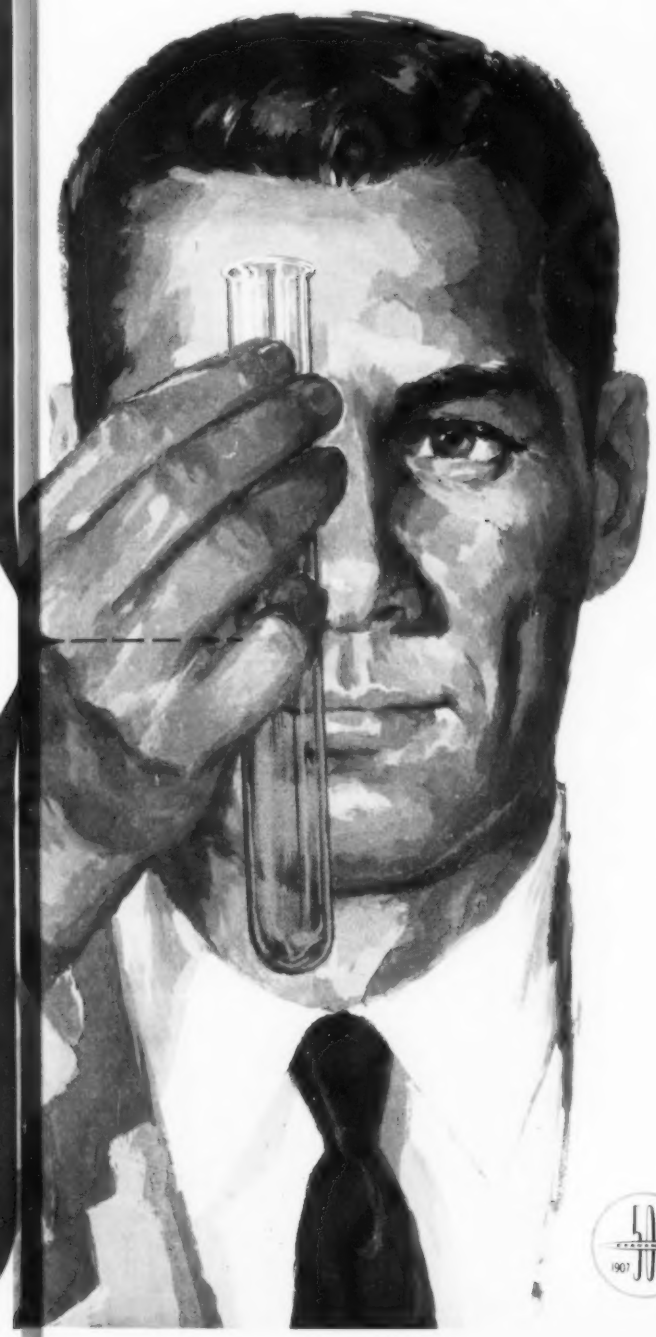
*Trademark

(To obtain more data on advertised products see page 230)

Efficient Refining... Better Oil Products

CYANAMID

teams with the petroleum industry in developing better products



The practical experience of oilmen is part of every catalyst, mud conditioner, antioxidant and additive offered by Cyanamid. Practical product development has stemmed from a working partnership between Cyanamid and petroleum engineers – a sound basis for re-evaluating established products and testing new ones. Result: new and improved products second to none in performance.

Creative research, coupled with volume production, exacting quality control and fast, anxious-to-help technical service, has featured Cyanamid's 50 years of growth as a chemical manufacturer. This product dependability has been serving the petroleum industry for two decades – and can be working for *you*

PRODUCT IMPROVEMENTS ARE SPURRED BY CYANAMID'S BROAD, CONTINUOUS RESEARCH

Your product requirements—and the problems of the petroleum industry—are the concern of many skilled, creative laboratory teams at the Stamford Research Laboratories. Basic information is obtained by outstanding research specialists using a full range of modern analytical and testing equipment. Actual operating refinery tests are the final stage in evaluating all these problem-solving products.

AMERICAN CYANAMID COMPANY
REFINERY CHEMICALS DEPARTMENT
30 Rockefeller Plaza, New York 20, N. Y.

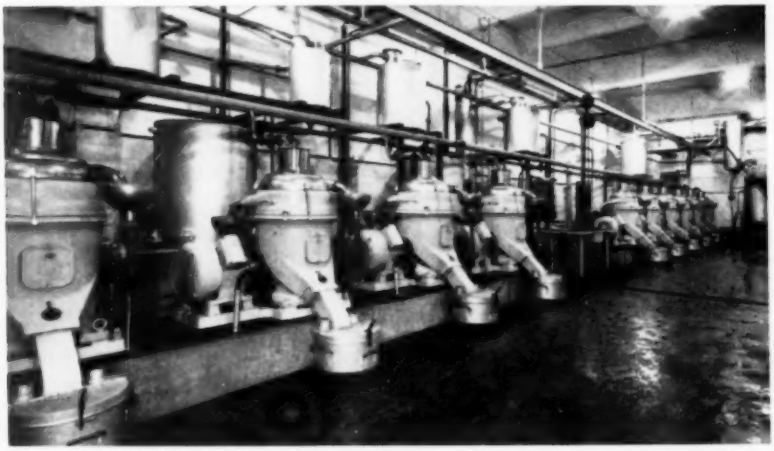
In Canada: North American Cyanamid Limited, Toronto and Montreal

(To obtain more data on advertised products see page 230)

EXTRA FAST DELIVERY
of *standard* Pfaudler stainless steel reactors now!
SEND FOR BULLETIN NO. 944

Pfaudler

Pfaudler Corrosioneering News Published by The Pfaudler Co., Rochester, N.Y.



In a single pass, these ten Titan No. 70 Superjectors separate animal fat, wash water, and solids.

Continuous centrifuging of slurries up to 35% solids

Titan Superjectors operate as long as a month *without shutdown for cleaning*

Now you can centrifuge *continuously* —eliminating costly, time-consuming clean-outs—with Titan Superjectors.

A series of ¼" slots around the bowl circumference discharge solids rapidly. Even with a slurry containing 35% solids, by volume, this cleaning action is completed in just 10 seconds.

The bowl's own centrifugal force builds up the hydrostatic pressure which opens the slots.

You can control this action manually or set it for automatic operation at prescribed intervals.

Concentrate solids up to 40%

Because the openings of the Titan's desludging *slots* are larger than those on nozzle-type centrifuges, much drier solids can be obtained. You can concentrate solids up to 40% by volume and also produce much clearer effluents at the same time.

The Titan Superjector handles mixed solid sizes up to ⅛" diameter. It removes solids either heavier or lighter than infeed.

Settling vanes within the Superjector curtail turbulence and shear of solids. You can adapt infeed holes and disc spacers closely to your product by selecting from the wide range of discs available.

Some typical installations

The following list gives some idea of the wide range of installations in which the Titan Superjector has proved its value:

Separating liquids from animal intestines for pharmaceuticals.

Refining vegetable oils.

Purifying waste lubricating oils.

Extracting fish oils.

Recovery of yeast and cereal proteins.

Lower running cost, other features

Since there is no braking effect from the continuous discharge of solids in the Titan Superjector, its power consumption is exceptionally low.

And, because many of its parts are interchangeable, you can convert the Titan to a variety of services at relatively low cost.

You can eliminate foaming, aeration, and gas loss by having the Superjector hermetically sealed and discharging fluids under pressure.

For further information, write for Bulletin 946.

How to take the guesswork out of buying columns

It's no easy matter to select the proper columns for a given operation.

You have to balance such diverse factors as cost, corrosion resistance, handling and cleaning, vapor and liquid capacity, pressure drop, load efficiency, etc., etc., etc.

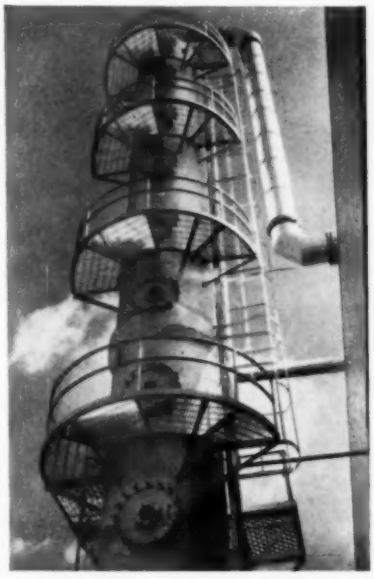
Pfaudler has had long years of experience designing and fabricating columns for fractionating, stripping, absorption, extraction, and numerous other chemical reactions.

You can make good use of our experience in fabricating with glassed steel, as well as a great many alloys, and from our design experience with bubble caps and perforated or sieve tray columns, Turbogrid tray column, as well as packed and spray type columns.

To begin with you can find the answers to many basic questions in our Bulletin No. 940. Check the coupon for a copy.

Then you can check with Pfaudler for detailed answers to your specific problems.

Result? Simply the right column for your process.



(To obtain more data on advertised products see page 230)

Corrosioneering News

Quick facts about services and equipment available to help you reduce corrosion and processing costs.

Pfaudler metals now run from "A"* to Zirconium

We feel that glassed steel is usually your most economical choice for corrosive service. There are applications, however, where glassed steel is not your best buy—so we maintain an arsenal of metals and alloys which you can also use where you encounter specific types of corrosion.

The latest addition to this arsenal is zirconium—a metal which has outstanding resistance to selected corrosive environments.

We've been working with zirconium for some time now, studying its virtues and its idiosyncrasies. From these studies we've acquired the experience needed to design and fabricate equipment of zirconium.

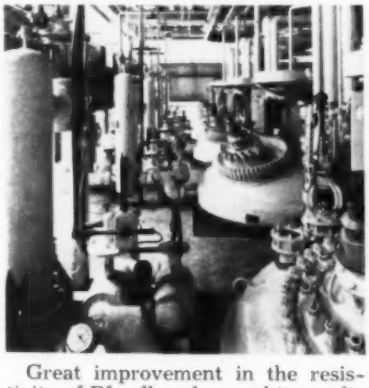
You may have seen an example of our fabrication ability at the International Atomic Exhibition where we displayed a two-gallon kettle made entirely of this metal.

With zirconium as well as glassed steel and such metals and alloys as Herculoy*, Everdur, titanium, copper, nickel, Inconel, clad materials, and stainless steel, Pfaudler offers you an impartial selection of the best material for use in your processing.

*Herculoy—a silicon-bronze alloy "A."

Glassed steel for the petroleum industry

The petroleum industry, like chemical processing, finds in glassed steel equipment a material of construction which is proving most economical in the battle against corrosion.

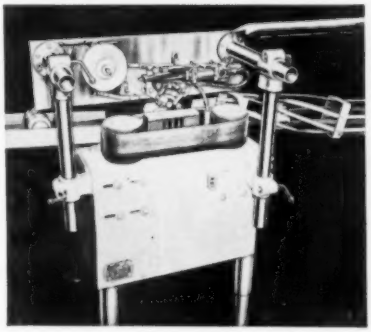


Great improvement in the resistivity of Pfaudler glass and its application to many different types of open hearth steel designs, are mainly responsible for this trend. Pfaudler glass, now resistant to all acids (except hydrofluoric) and to alkaline solutions to pH 12 at 212° F., provides about as much flexibility as you can find in any one material of construction.

Used in the form of reactors, columns, settlers, mixers, storage tanks, pipe, fittings and valves, Pfaudler equipment is giving excellent service for reactions involving hydrochloric acid, chlorinated solvents, pesticides, vapor degreasing solvents, etc. It is also used in the hydration of olefins, to prevent corrosion by sulphuric acid, in certain phases of producing cumene-derived phenol and by-product acetone in polyester resins and synthetic fibres.

Installations of Pfaudler glassed steel polymerizers are so numerous that standardized designs have been developed. Glassed steel can be cleaned quickly after each run; a build-up of product within the vessel is easily prevented.

In petroleum refining operations, corrosion during crude distillation has been minimized. Glass helps to prevent passage of hydrogen to the steel surface, eliminating atomic hydrogen attack. There are other applications too numerous to include here. May we send you Bulletin 932?



Outserts for your package attached automatically

Now you can attach promotional messages, recipes, directions, etc. to the outside of packages on a production line basis at minimum cost—no expensive hand labor required. The Pfaudler Outserter attaches messages to cylindrical, flat, and tapered containers of glass, metal, plastic, or paper material—and exactly where you want it. The machine requires only 4 ft. of floor space and fits readily into most production lines. It is time tested, rugged in design and construction and requires no costly maintenance. Let us analyze your needs. Bulletin 933 describes features and advantages.

THE PFAUDLER CO., DEPT. PP-77, ROCHESTER 3, N.Y.

Please send me the following: ☐ Titan Superjector Bulletin 946; ☐ Pfaudler Columns Bulletin 940; ☐ Pfaudler Buyer's Guide Bulletin 947; ☐ Pfaudler Outserter Bulletin 933; ☐ Pfaudler Stainless Steel Reactors Bulletin 944; ☐ Pfaudler PVC Polymerizers Bulletin 932.

Name .....

Title .....

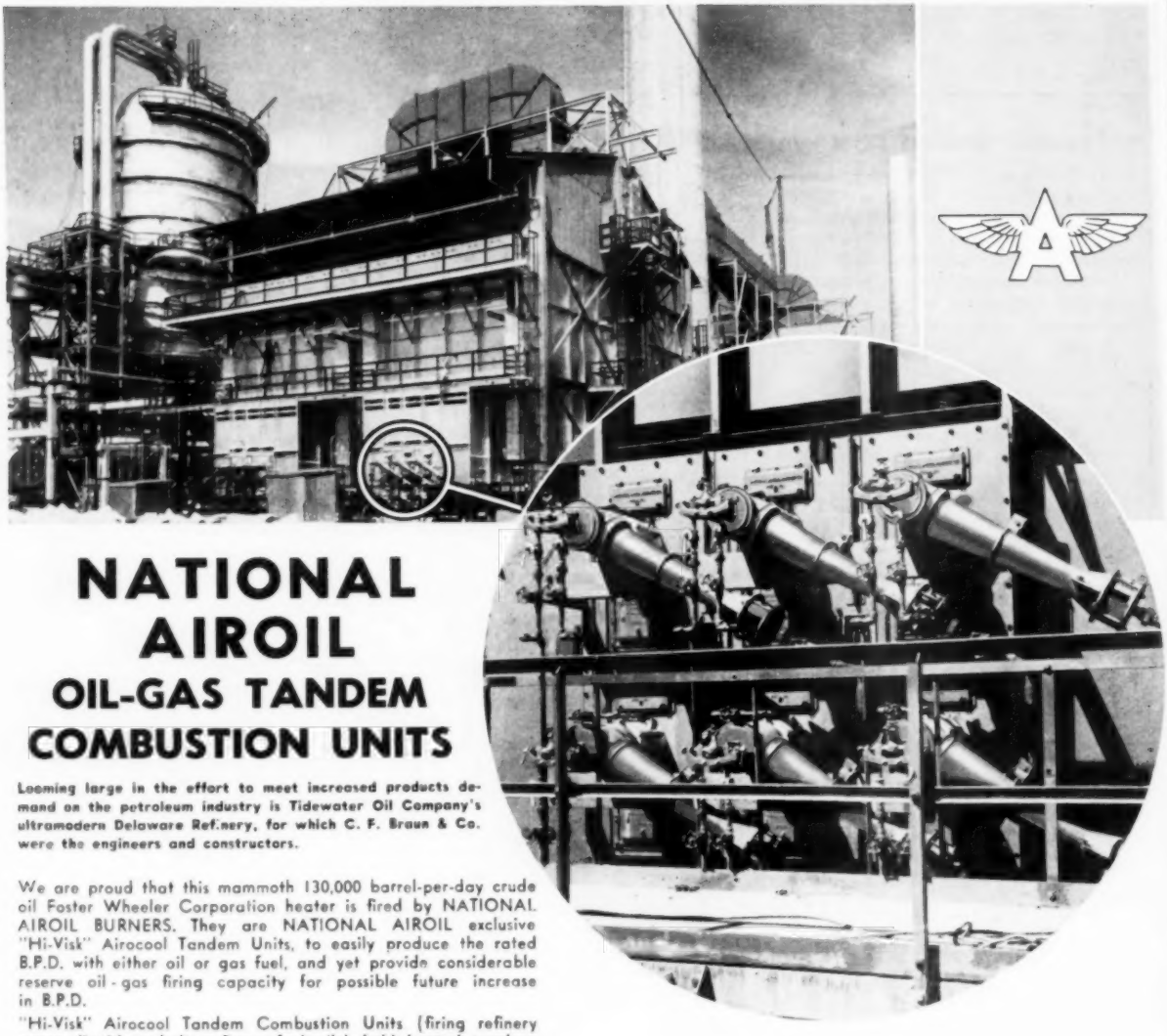
Company .....

Address .....

City ..... Zone ..... State .....

(To obtain more data on advertised products see page 230)

Firing CRUDE DISTILLATION UNIT HAVING WORLD'S HIGHEST THRUPUT...



NATIONAL AIROIL
OIL-GAS TANDEM COMBUSTION UNITS

Looming large in the effort to meet increased products demand on the petroleum industry is Tidewater Oil Company's ultramodern Delaware Refinery, for which C. F. Braun & Co. were the engineers and constructors.

We are proud that this mammoth 130,000 barrel-per-day crude oil Foster Wheeler Corporation heater is fired by NATIONAL AIROIL BURNERS. They are NATIONAL AIROIL exclusive "Hi-Visk" Airocool Tandem Units, to easily produce the rated B.P.D. with either oil or gas fuel, and yet provide considerable reserve oil-gas firing capacity for possible future increase in B.P.D.

"Hi-Visk" Airocool Tandem Combustion Units (firing refinery gases, liquid asphalt, refinery fuel oils) hold heated combustion air within the high temperature zone until fuels and air are thoroughly mixed. This means that combustion takes place under the best conditions; the result: increased fuel efficiency with a minimum of excess air. They are in use in Petroleum Refineries throughout the world.

NATIONAL AIROIL Tandem Units provide extra flame travel *without adding to the furnace depth*, elimination flame inpingement on walls and tubes, extending the life of those elements; and because of this added flame length, the heat is more uniformly distributed.

The Tandem Unit is popularly fired with NATIONAL AIROIL Combination Oil and Gas Burners. YOU will realize higher profits from YOUR heaters when Tandem Combustion Units are specified.

OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes: STEAM ATOMIZING OIL BURNERS; MOTOR-DRIVEN ROTARY OIL BURNERS; MECHANICAL PRESSURE ATOMIZING OIL BURNERS; LOW AIR PRESSURE OIL BURNERS; AUTOMATIC OIL BURNERS, for small process furnaces and heating plants; GAS BURNERS; COMBINATION GAS and OIL BURNERS; FUEL OIL HEATERS; FUEL OIL PUMPING and HEATING UNITS; FURNACE RELIEF DOORS; AIR INTAKE DOORS; OBSERVATION PORTS; SPECIAL REFRACTORY SHAPES.

CHEMICAL-PETROLEUM DIVISION

NATIONAL AIROIL BURNER CO., INC.

***Main Office & Factory:* 1297 EAST SEDGLEY AVENUE, PHILADELPHIA 34, PA.**

Southwestern Division: 2512 South Boulevard, Houston 6, Texas

INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

(To obtain more data on advertised products see page 230)

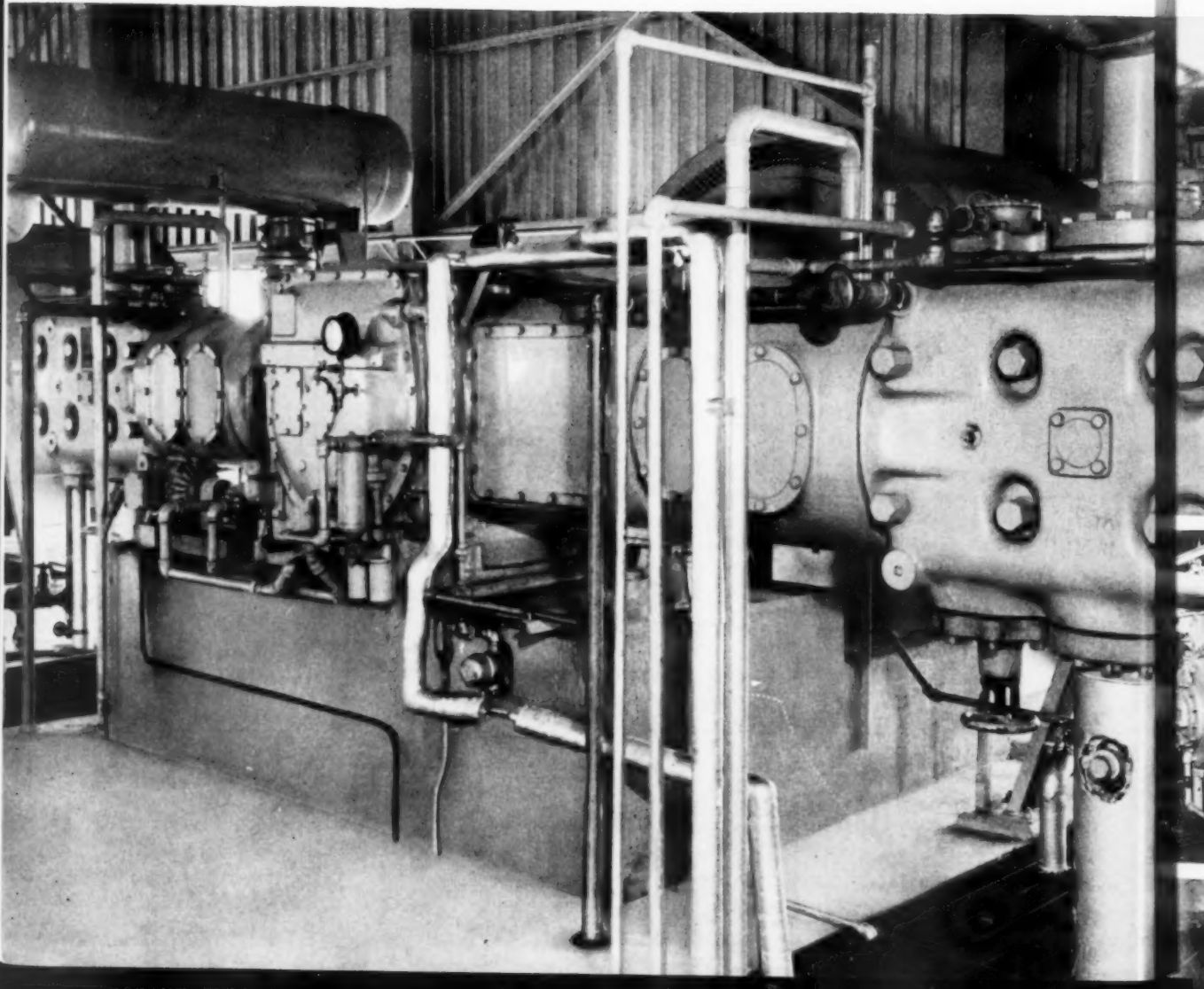
This Complete Organization for Engineering and Construction of your plant is available on a **"SHORT-TERM LEASE"**

McKee
ENGINEERING &
CONSTRUCTION
Services

YOUR new-plant contract with McKee is a short-term lease on the specialized knowledge, diversified talents and half-century experience of one of the world's large engineering organizations. The photos above show only a part of the large staff of engineers, technical specialists, purchasing facilities and skilled construction personnel available to execute every detail of your project regardless of size or location.

Arthur G. McKee & Company • Engineers and Contractors
Headquarters: McKee Building • 2300 Chester Avenue • Cleveland 1, Ohio
Offices: New York, N. Y. • Union, New Jersey • Washington, D. C.
British Representatives of Metals Division: Head, Wrightson & Co., Limited
Canada: Arthur G. McKee & Company of Canada, Ltd., 372 Bay St., Toronto

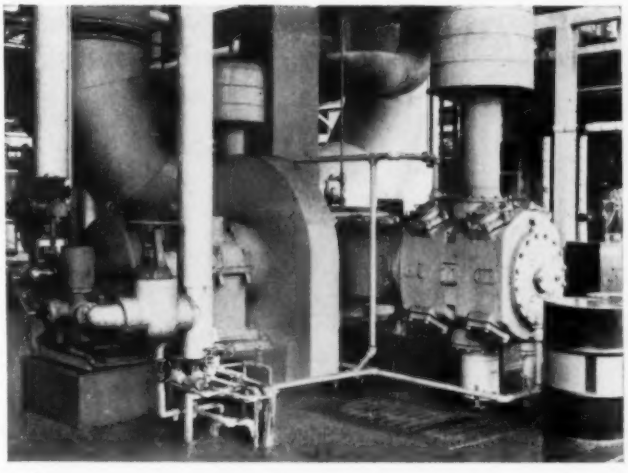
Cooper-Bessemer



▲1 This 2-cylinder FM compressor, steam turbine driven, supplies aeriation air for this new Tidewater installation.

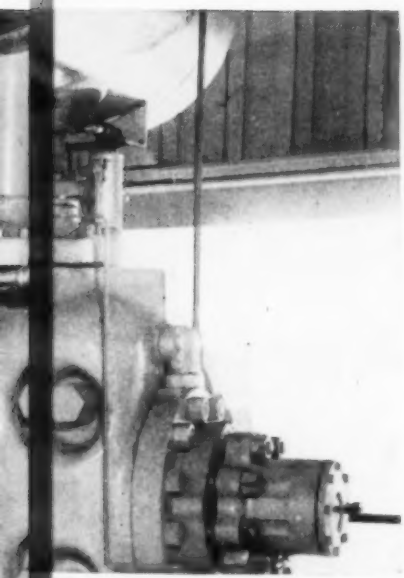
▲2 To maintain absolute purity in hydrogen compression, this compact motor-driven FM is equipped with non-lubricated cylinders.

▲3 Handling industrial air requirements for Tidewater's Delaware refinery . . . three 4-cylinder Cooper-Bessemer compressors,—one synchronous driven and two steam turbine driven.

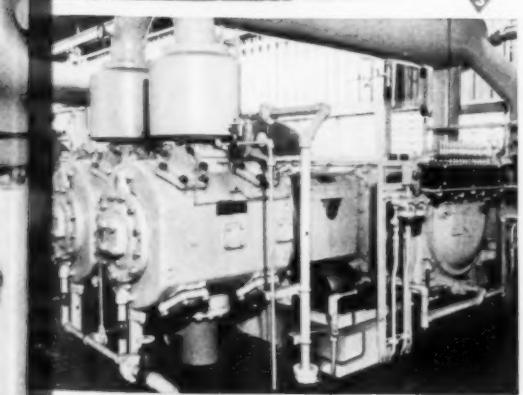


▲1

FM Compressors



▲2



▲3

...for simplicity and efficiency in meeting multiple requirements in the world's largest refinery ever to be built at one time

In Tidewater's giant Delaware Flying A Refinery, Cooper-Bessemer FM compressors meet multiple service requirements with extreme efficiency and at the lowest possible cost.

Handling the compression of hydrogen and air these flexible units . . . motor and steam turbine driven . . . deliver the usual high standards of Cooper-Bessemer availability and performance. In addition, interchangeability of parts greatly reduces required inventories and keeps space requirements at a minimum.

Combining rugged strength and stamina with natural force balance, Cooper-Bessemer offers a compressor size and type to meet the most exacting needs. Write today for further information.

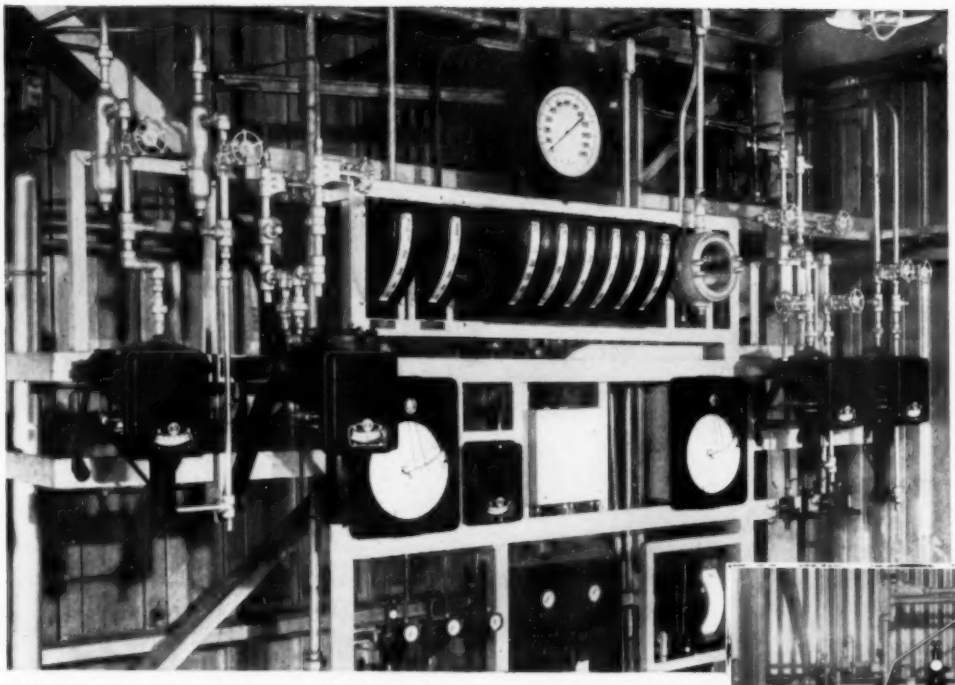
BRANCH OFFICES: Grove City • New York • Chicago • Washington • San Francisco • Los Angeles • Houston • Dallas • Odessa • Minneapolis • New Orleans • Shreveport • Casper

SUBSIDIARIES: Cooper-Bessemer of Canada, Limited . . . Edmonton • Calgary • Halifax
Cooper-Bessemer International Corporation . . . New York
Caracas • Havana • Mexico City

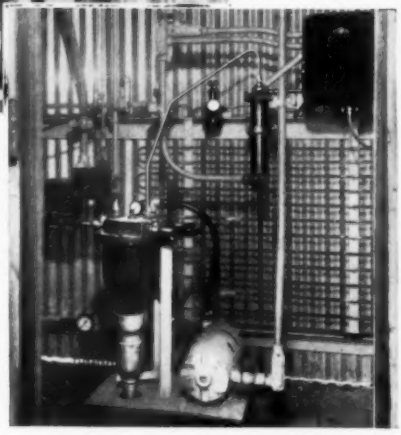
Cooper Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

ENGINES: GAS - DIESEL - GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL
ENGINE OR MOTOR DRIVEN



These Bailey Pneumatic Transmitters on CO boiler at Tidewater measure and transmit: Fuel gas flow, drum level, per cent oxygen, steam pressure, furnace temperature, CO gas flow, steam flow, duct and furnace pressures. Other Bailey transmitters (not shown) measure feed water flow, oil flow, air flow, and steam temperatures.



Bailey Gas Analyzer for oxygen and combustibles in flue gas.

Bailey Control for CO Boiler at Tidewater...

Bailey Instruments and Controls help Tidewater Oil Company to secure design performance from the new carbon monoxide boiler in its Delaware Refinery. The Bailey Equipment here is of the pneumatic transmission type operating on a standard 3-15 psi signal range. This allows a wide selection of receiving instruments for control room service.

Bailey Controls on the CO Boiler function to maintain:

1. Steam Pressure
2. Steam Temperature
3. Elevated Furnace Temperature for combustion of CO
4. Optimum fuel-air ratio for all mixtures of CO and supplementary fuels
5. Safe water level in boiler drum
6. Proper differential between pressures in boiler drum and at feed water pump outlet
7. Circulation through boiler feed pumps.

For combustion "know-how" with standardized instrument and control components, see your local Bailey Engineer or call our headquarters at Cleveland.

CP2-1

BAILEY BUILDING BLOCK METHOD

BAILEY METER COMPANY
CHEMICAL AND PETROLEUM DIVISION
1024 IVANHOE ROAD, CLEVELAND 10, OHIO
In Canada—Bailey Meter Company Limited, Montreal

RESULTS IN: FLEXIBILITY, SIMPLICITY, ECONOMY

BAILEY METERS

(To obtain more data on advertised products see page 230)

DU PONT *Petroleum Chemicals* NEWS

Number 77 in a Series of Bulletins for the Petroleum Industry JULY 1957

Sludge problems in residual fuels minimized by Du Pont additive

ASSISTANT GENERAL MANAGER . . . ORCHEM

DR. WILLIAM C. KAY is Assistant General Manager of the Organic Chemicals Department of the Du Pont Company.

He started work with Du Pont as an industrial engineer at the Chambers Works in 1934. He became project engineer in 1939, and joined the neoprene manufacturing organization as chief supervisor in 1941.

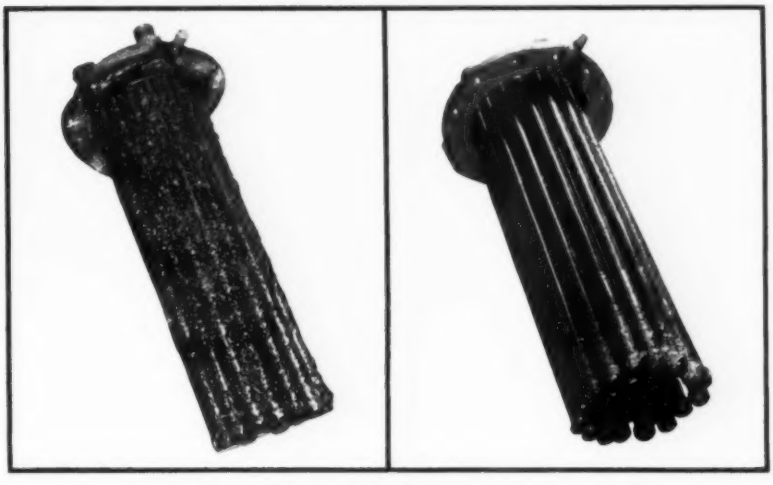
In 1943, Dr. Kay was assigned to the atomic project at Oak Ridge, Tennessee, as production superintendent. From there, he moved to the Hanford Works plutonium project in Washington. He was named Process Manager of the Du Pont Grasselli Chemicals Department in 1947.

Dr. Kay in 1950 joined the Explosives Department as Director of Manufacturing for the Atomic Energy Division. He assumed the same position in the Organic Chemicals Department in 1955. His appointment as Assistant General Manager occurred at the beginning of this year.

Dr. Kay earned his B.S. and Ph.D. degrees, respectively, at the University of Minnesota and M.I.T.

Sludge-packed systems cleaned and KEPT clean

It is, of course, a well-known fact that residual fuels too often cause serious problems. Being the "bottom of the petroleum barrel," they contain, in concentration, all the impurities from the lighter oils which have been distilled off.



PREHEATER TUBE-FOULING . . . solved by FOA-2

TO REVIEW THE PROBLEM . . .

Insoluble sludge is likely to form in residual fuels—in storage, in transit or in use. That, briefly, is problem No. 1.

Problem No. 2: Residual fuels, when blended, are often incompatible. Insoluble sludge is likely to form.

Du Pont Fuel Oil Additive No. 2 solves both problems.

Sludge cure

When sludge forms, trouble starts in the form of clogging. Many times nothing short of costly major "surgery" will start the oil flowing. So tank walls are cut through, sludge is removed mechanically, and the hole is patched up.

Oftentimes it is found that fuel system parts, filters, strainers, nozzles, preheater tubes and shells, have become clogged. While mechanical cleaning sometimes restores their functions, expensive replacements are sometimes necessary.

With these corrective measures going on, *downtime* is mounting, and labor costs are keeping pace.

Many other residual fuel users know that such an operation isn't necessary, that FOA-2 would have cleaned the tanks and parts, restored operation of the system. No cutting into tanks, no cleaning or parts-replacement, no heavy labor expense. Downtime? Greatly reduced.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT *Petroleum Chemicals* NEWS

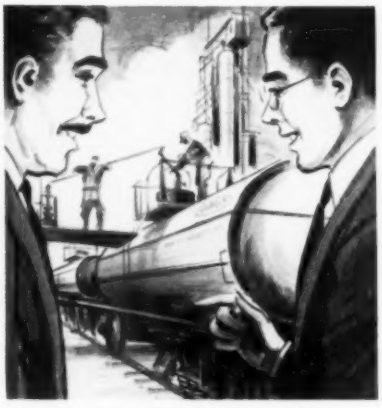
Du Pont is always prepared to meet your emergency TEL needs

REFINERY SUPERINTENDENT:

We're in a jam. Our next regular TEL delivery is not due for another 10 days. But our refinery is gearing up to meet an unexpectedly heavy demand . . . and we don't have enough TEL to do the job.

DU PONT REGIONAL SALES OFFICE MANAGER:

Don't worry about it. We have several tank cars of TEL on a siding only a few miles from here. We can get a couple of cars over first thing in the morning.



REFINERY SUPERINTENDENT:

The TEL cars arrived this morning. That's service . . . less than 24 hours to deliver. It's good to know we can get that kind of service when we need it.

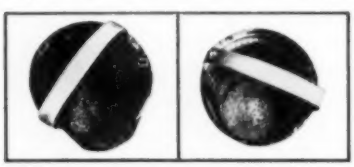
CONTINUED

Sludge problems

How it works

FOA-2 added to residual fuel attacks insoluble sludge, reduces the size of the particles which compose it, suspends them. Thus the fuel flows freely through the system. There is no blockage of nozzles, lines, filters, strainers and other parts. Oil, suspended sludge particles, and the FOA-2 burn completely.

Once a system is cleaned with FOA-2, small amounts of the additive *keep* it clean. That's because FOA-2



STRAINER-PLUGGING . . . solved by FOA-2

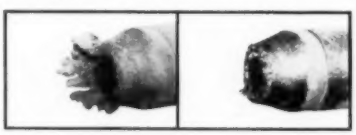
is a stabilizer and solubilizer as well as a dispersant.

FOA-2, being nonmetallic, is ashless and leaves no residue after burning.

Case histories prove power of FOA-2

Early this year we assembled in one technical memorandum ten case histories documenting the power of FOA-2 to clean, and to keep clean, systems fueled by "barrel-bottom" residuals.

We believe you will be interested in the ease and economy of using FOA-2, and suggest that you write for Technical Memorandum No. 317, dated January 1957.



NOZZLE-FOULING . . . solved by FOA-2

Director of Petroleum Laboratory Appointed to NACA Subcommittee

Dr. Bernard M. Sturgis, director of the DuPont Company's Petroleum Laboratory, Deepwater Point, N. J., has been appointed to the National Advisory Committee for Aeronautics subcommittee for aircraft fuels.

Subcommittees of the NACA assist in initiating research programs, advising upon technical problems, reviewing current research throughout the nation, recommending new areas of research, and coordinating research programs. NACA objectives are to anticipate the research needs of aviation and to supply the armed forces and industry with basic information for the design and production of aircraft.

DuPont's Petroleum Laboratory devotes a considerable part of its research effort to aircraft fuels and lubricants.

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DU PONT
REG. U.S. PAT. OFF.

Better Things for Better Living
. . . through Chemistry

OVER

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

A-4801

Printed in U. S. A.

TRECO – CONTRACTOR TO AMERICA'S FAMOUS REFINERS*

The REFINERY ENGINEERING Company is proud to have served the majority of America's best-known refiners in the field of Engineering, Design and Construction. Each year sees our list of satisfied clients expanding.

Back of this steady expansion is the satisfactory completion of each contract on, or ahead of time; the ease and economy of operation of the plant as well as the small amount of "down time."

Treco has purchased a tract of land, in excess of three acres. This new facility provides more than 14,000 square feet of air-conditioned offices with paved parking for over 200 cars. There is also a cafeteria building and two other buildings of 9,700 feet and 37,000 feet of space for expanding Treco activities.

* The Trade Marks above are of the companies Treco has recently served.

The REFINERY ENGINEERING Company has just produced a brochure which shows the Company's facilities with photographs of completed projects. A copy will be mailed you promptly upon request on your company's letterhead.

ESSO STANDARD OIL COMPANY

McCOLL-FRONTENAC OIL COMPANY, LTD.

PHILLIPS PETROLEUM COMPANY

CONTINENTAL OIL COMPANY

SHELL OIL COMPANY

THE TEXAS COMPANY

SINCLAIR REFINING COMPANY

COSDEN PETROLEUM CORPORATION

D-X SUNRAY OIL COMPANY

ROYALITE OIL COMPANY, LTD.

KERMAC

KERR-McGEE OIL INDUSTRIES, INC.

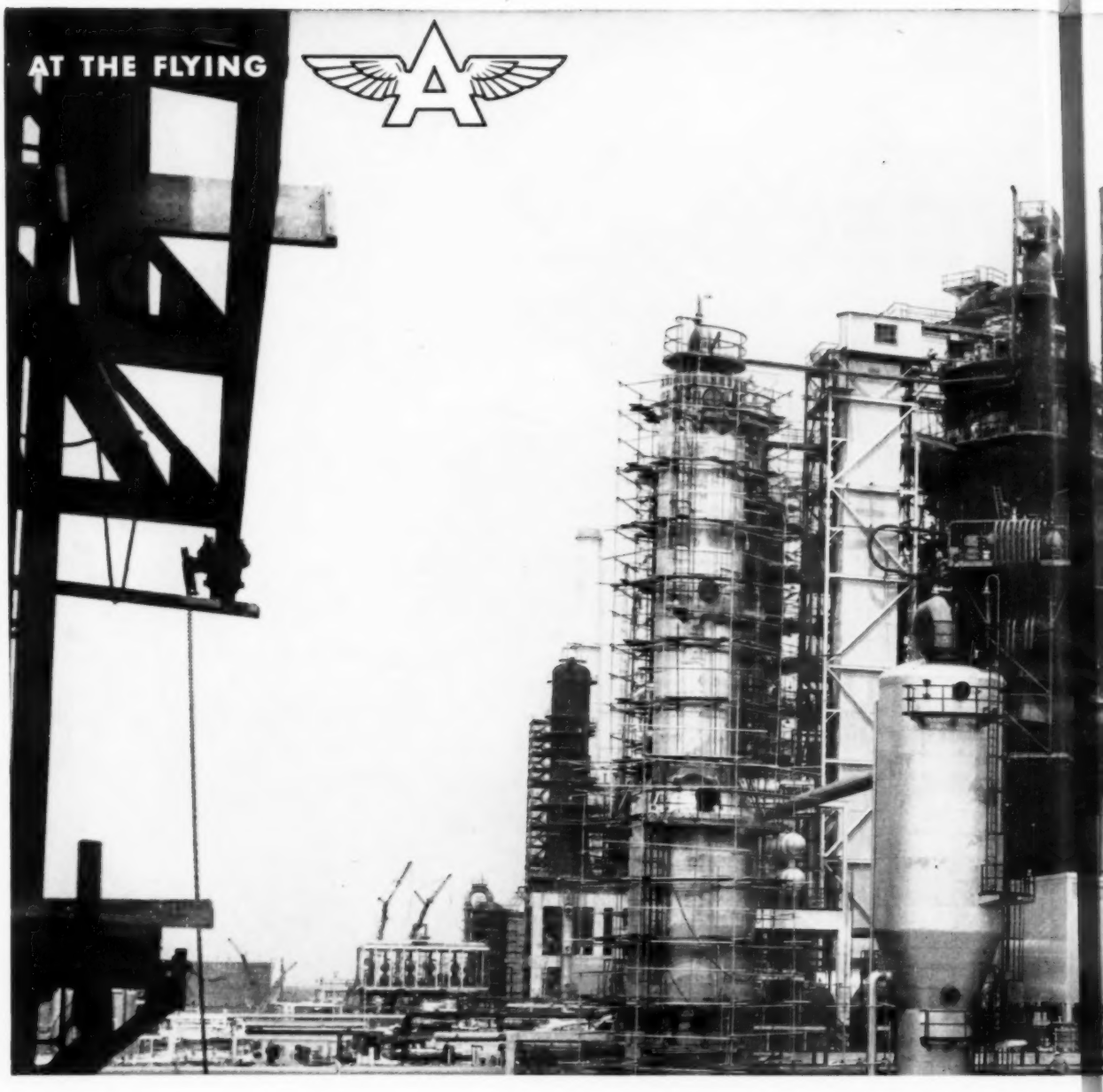
TRECO

A DIVISION of VITRO CORPORATION of AMERICA

The REFINERY ENGINEERING Company

NEW YORK TULSA TORONTO

(To obtain more data on advertised products see page 230)



Each a towering problem solved with

NEW TIDEWATER DELAWARE FLYING A REFINERY TAKES 12 TYPES—1,800 TONS

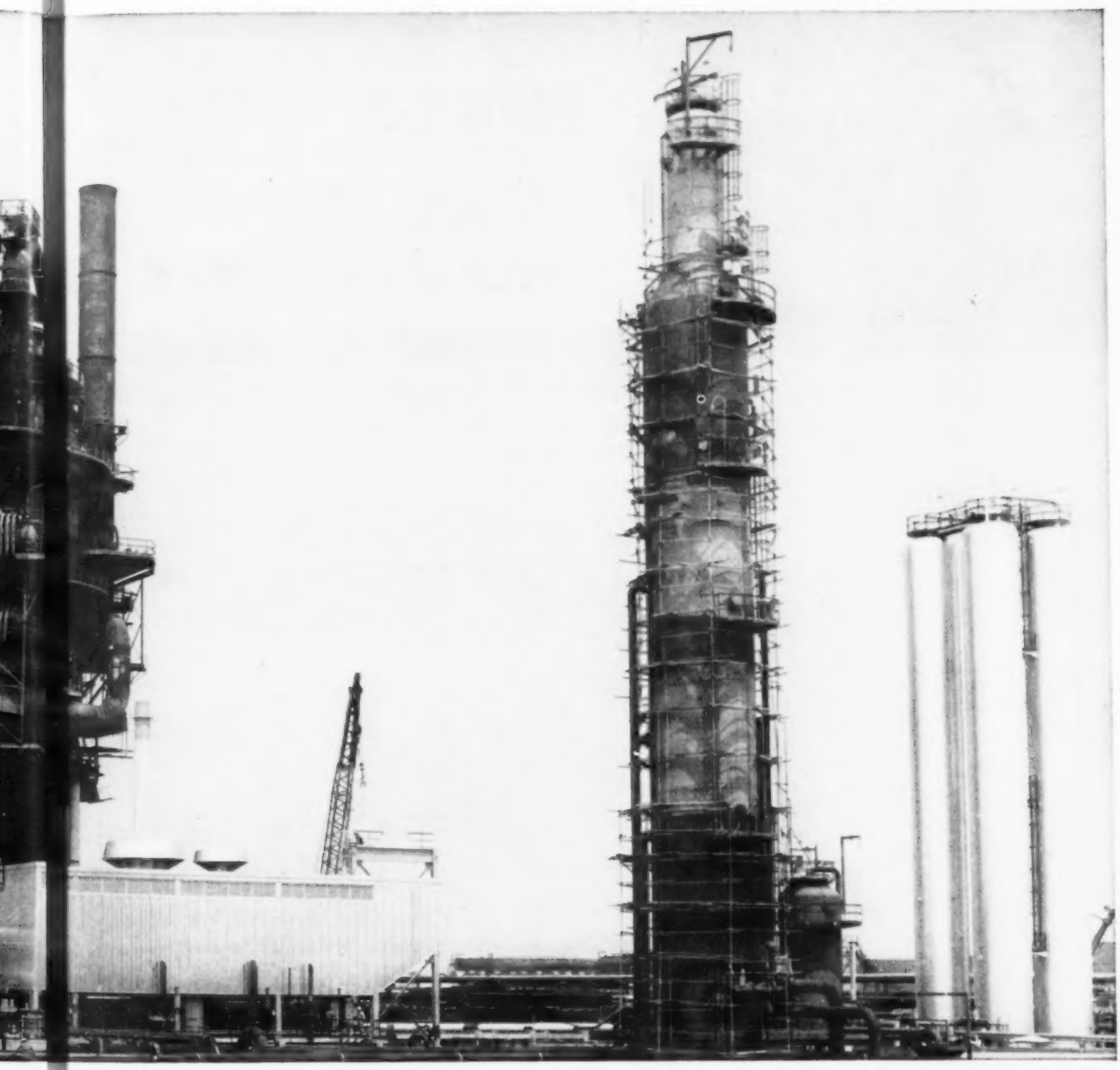
Choosing from the widest range of such materials available from any source, designers and fabricators for Tidewater carefully selected Lukens clad and alloy steels for the heart of its new Delaware Flying A Refinery.

To resist the corrosive attack of sulfur compounds and naphthenic acid—Lukens stainless clad types 316-L, 405 and 410; for chlorides—Lukens Monel-clad; for high-temperature service—Lukens A-204 alloy; to resist hydrogen attack and graphitization and for strength at high temperatures—Lukens A-301 alloy.

And for economical protection against a variety of other corrosive and abrasive problems Tidewater chose 6 additional types of Lukens clad steels—Inconel, nickel and copper; 304, 304-L and 316 stainless.

Lukens clad steels offer all the protection of solid high alloy—economically. The bond is permanent; you can use the combined gage of cladding and backing metals in designing to meet Code requirements. Flanges and pipes can be welded on, even after vessel installation.

(To obtain more data on advertised products see page 230)



Lukens clad and alloy steels

Consult your equipment builders, or write for the new **Clad Steel Equipment** bulletin and information on alloy steels. Manager, Marketing Service, Room 898, Lukens Steel Company, Coatesville, Pa.

This is Lukens clad steel, a proven product. Not a lining, not a soldered-on surface, but a solid steel plate—one side corrosion-resistant high alloy, the other economical alloy or carbon steel permanently bonded on powerful rolling mills.

LUKENS ®

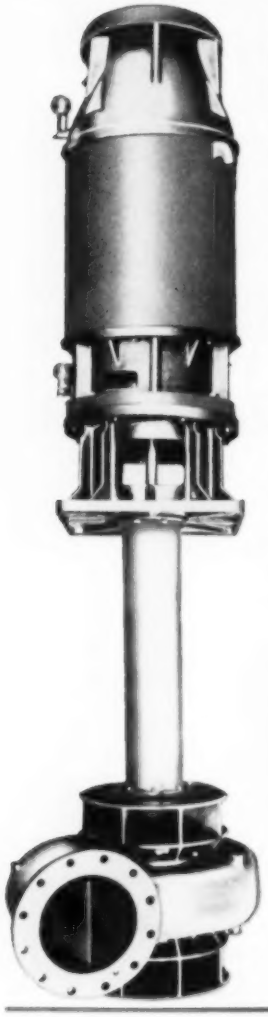
Helping industry choose steels that fit the job

(To obtain more data on advertised products see page 230)

Bingham

TYPE "VS" DOUBLE SUCTION DOUBLE VOLUTE VERTICAL PUMP

REDUCES COSTS WITH SHALLOW PIT LOWER MAINTENANCE



SPECIALLY DESIGNED FOR WET-PIT SERVICES. COOLING TOWER, SPRAY POND, DISPOSAL SUMP, WATER SUPPLY, DRAINAGE — AND OTHER HIGH-CAPACITY, MEDIUM-HEAD WET-PIT SERVICES.

The BINGHAM "VS" Pump, which is an advanced design of a "Double Volute"—"Double Suction" single stage pump, saves money in three ways: (1) Lower installed cost because it does not require a deep pit and can use standard motors. (2) Lower operating cost, because it operates at higher efficiencies, uses less power. (3) Lower maintenance cost, because there is no stuffingbox, all bearing loads are light, and the installation is easy to inspect and service.

The "Double Volute" construction of the "VS" Pump maintains radial balance of its rotating element throughout the entire operating range of the pump. Wear due to "Side Push" is eliminated.

The "Double Suction" feature of this pump eliminates axial hydraulic thrust, thereby permitting the use of standard vertical motors.

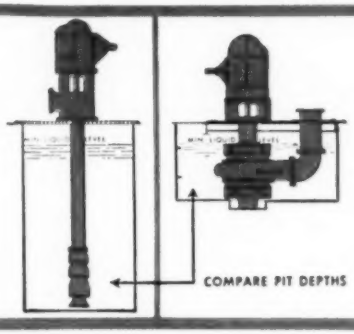
These and many other important reasons make the BINGHAM "VS" Pump the most logical choice today for wet pit service. For full details call your nearest Bingham Office or write for Bulletin No. 110.

A Battery of Bingham "VS" Pumps Operating at a major Gulf Coast gas processing plant.

COMPARE THESE PITS FOR COST

OLD

Conventional Deep-Well Turbine Pump Installation . . .
requires the pit be deep enough to maintain sufficient pumpage above the pumping element in order to provide the required NPSH.



NEW

Bingham "VS" Pump Installation . . .
requires only a shallow pit and only sufficient pumpage to cover the pumping elements. Pit construction is thereby greatly reduced.

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY
General Offices: 2800 N.W. Front Avenue, Portland 10, Oregon
Factories: Portland, Ore. • Vancouver, B. C., Canada

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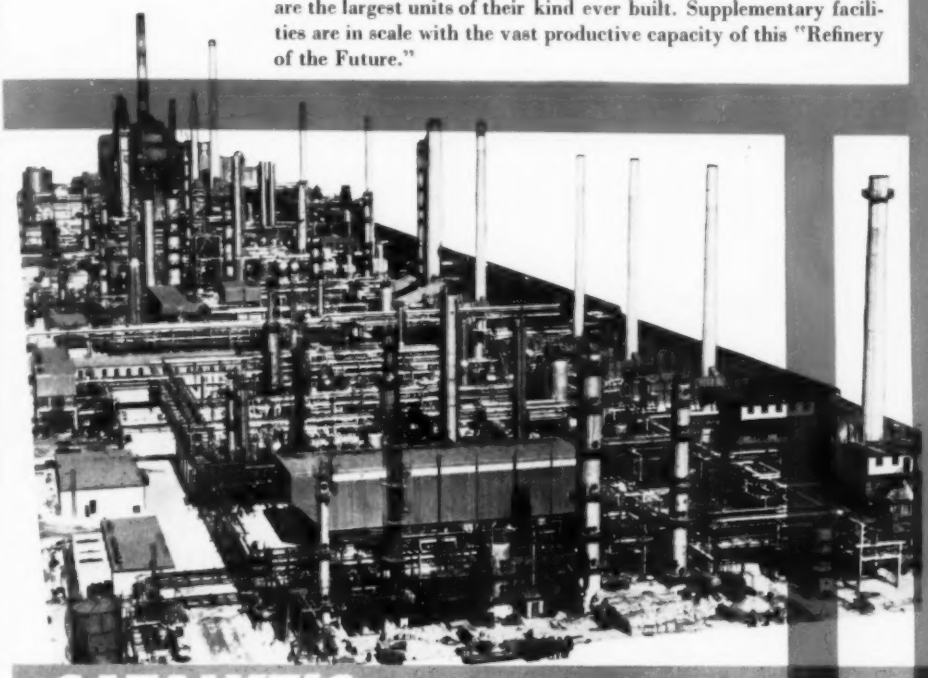
TORONTO, ONT., CAN.
VANCOUVER, B. C., CAN.

(To obtain more data on advertised products see page 230)

TIDEWATER—builds for the future

Tidewater Oil Company's new refinery near Wilmington, Delaware, is the largest refinery ever built as a single project. It has a total capacity of 130,000 barrels per day. Its crude unit, Orthoflow fluid catalytic cracking unit, fluid coker and 45,000 BPD Houdriformer are the largest units of their kind ever built. Supplementary facilities are in scale with the vast productive capacity of this "Refinery of the Future."



CATALYTIC—maintenance for the future

Catalytic's record in maintenance of refineries and other industrial plants has won it the maintenance contract for this gigantic new Tidewater enterprise. It assures Tidewater Oil Company of professional engineering type service that works in coordination with Tidewater's own staff. It means a minimum, highly productive, flexible force on the job only as required . . . with qualified mechanics available for turn-around periods.

Catalytic's contract maintenance service means more profits and less operating expense. Write for information on Catalytic Contract Maintenance.

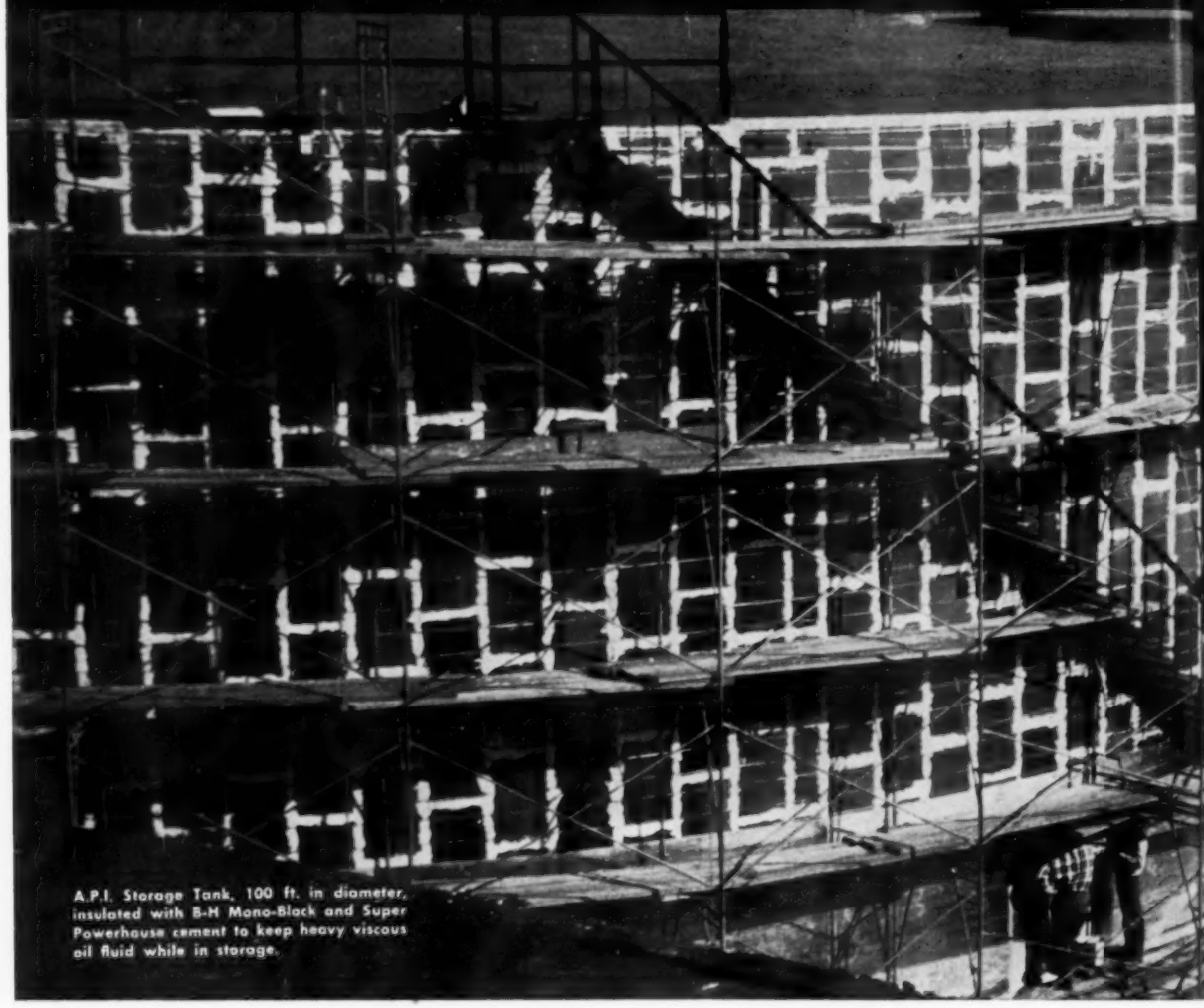
CATALYTIC
Construction Company

Philadelphia 2, Pennsylvania
Toledo, Ohio
In Canada: Catalytic Construction of Canada, Limited; Sarnia, Ontario; Toronto, Ontario; Montreal, Quebec

Catalytic *On-Time* . . . *On-Budget* Services
for the metallurgical, chemical, petrochemical and oil refining industries: Project Analysis; Process Development; Process Design; Economic Studies; Engineering; Procurement; Construction; Plant Operation.

50 Carloads of **BALDWIN-HILL MONO-BLOCK®**

Seal in Heat... at Tidewater Oil Company's Delaware Refinery



A.P.I. Storage Tank, 100 ft. in diameter, insulated with B-H Mono-Block and Super Powerhouse cement to keep heavy viscous oil fluid while in storage.

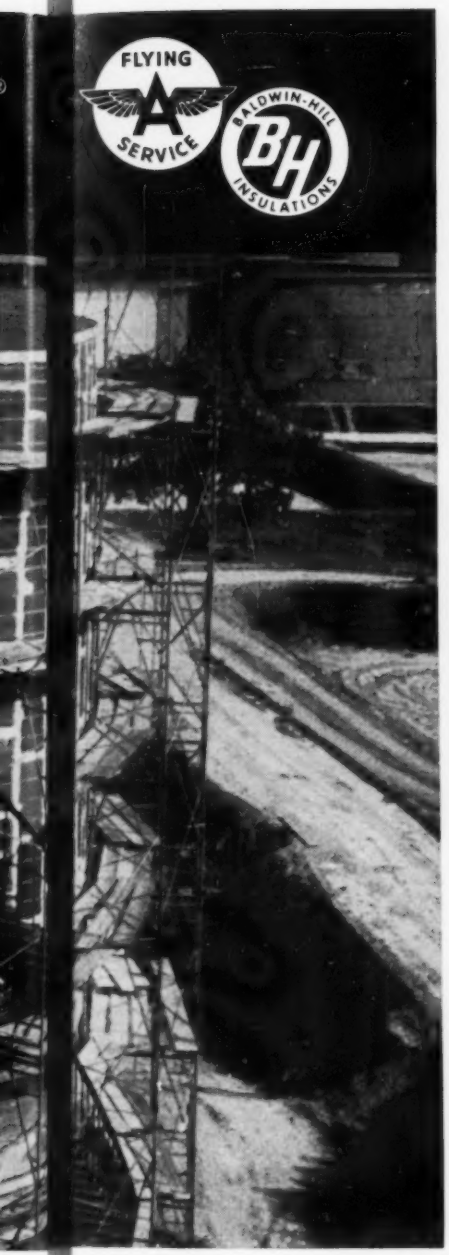
Full Temperature Range Covered by One-Block Insulation

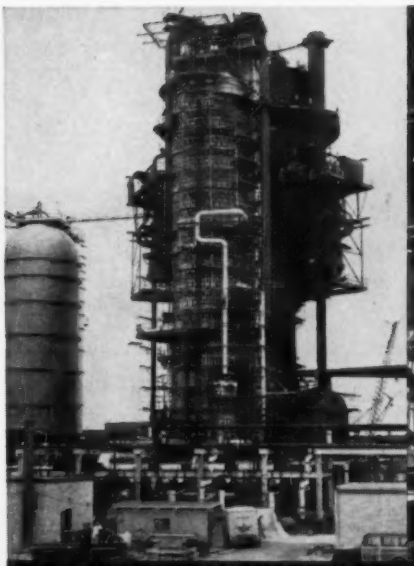
For Tidewater's Oil Company's new refinery, C. F. Braun & Co., Engineers and Constructors, standardized on B-H MONO-BLOCK to help prevent costly heat losses and permit better control of operating temperatures. The mammoth job required over 1,000,000 bd. ft. of MONO-BLOCK. This material eliminated the need to purchase and stock special insulating blocks for both low and high temperatures since it is efficient over all temperatures from 75° to 1700° F. Baldwin-Hill's "2 in 1" insulating block reduced inventory control—and its cost—to the minimum.

B-H MONO-BLOCK is felted of long, spun mineral wool fibers and compressed into rigid block with excellent structural strength. It is resilient with an ability to conform to irregular and large curved surfaces without evidence of fracture. MONO-BLOCK is light in weight, extremely simple to handle and apply. It is easily cut with knife or saw to fit odd shapes or smaller areas as required. Stability is assured under severe temperature conditions and it is unaffected by exposure to moisture. . . . In addition, B-H SUPER POWERHOUSE CEMENT was used to point all joints, insuring a tight, unbroken heat barrier, and then applied in a single ½" coat, where required, as an insulating-finishing cement.

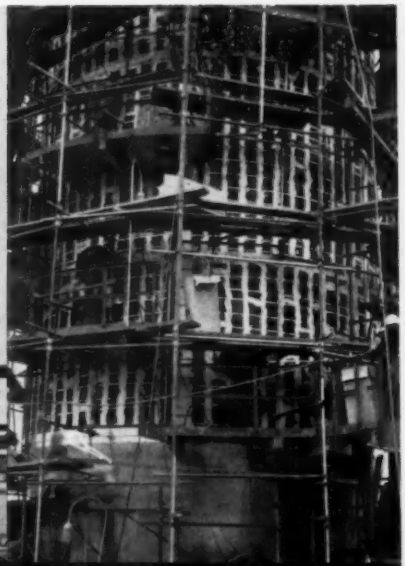
FLYING A SERVICE

BALDWIN-HILL BH INSULATIONS





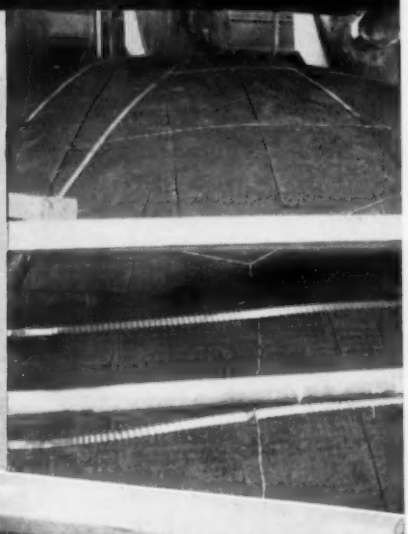
Thirty-five stories high, this giant cat cracker is covered with B-H Mono-Block and pointed with B-H Super Powerhouse Cement.



Close-up showing B-H Mono-Block applied to Atmospheric Tower and pointed with B-H Super Powerhouse Cement to seal all joints.

On large vessels, ends of expander straps are fastened to vertical support bars, spaced to allow 1 inch circumferential expansion.

Note how B-H Mono-Block is easily cut and shaped to fit on spherical heads of vessels.



BALDWIN-HILL CO.

Complete line of Industrial Insulations

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See our catalog in Sweet's Plant Engineering File.

BALDWIN-HILL BH INSULATIONS

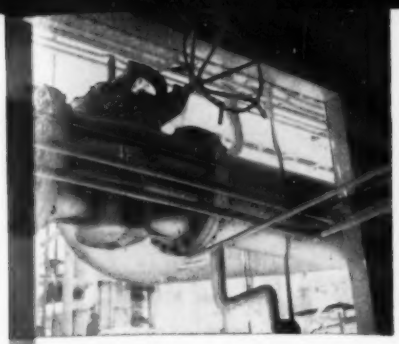
For complete report on this installation, staple the keyed corner of this ad to your letterhead and mail.

J-375

where to save refining dollars

WITH

ROCKWELL-Nordstrom **VALVES**



CATALYTIC CRACKING

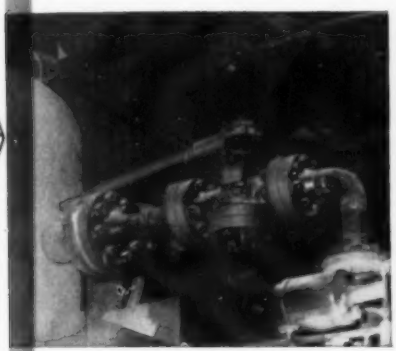
From the smallest valves to the large emergency flow line valve above, Rockwell-Nordstrom valves keep process units on stream without costly down time. Lubricant stops valve trouble *before* it has a chance to start.

HEAT EXCHANGERS

The Rockwell-Nordstrom valve shown above on exchangers on the recovery side of a fluid cat unit insures trouble-free flow control. Since the plug is fully opened or closed with just a quarter-turn, gear operation is two to five times faster.

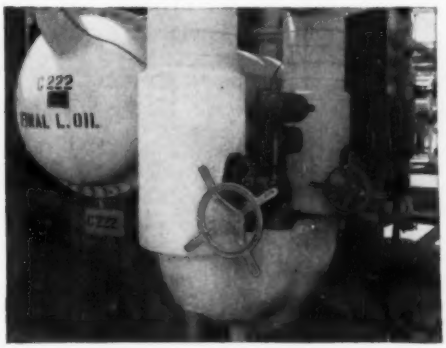
WATER SERVICE

On intake or discharge water lines, Rockwell-Nordstrom valves—20" valve shown above—operate easily and won't stick. The perfectly seated plug is "cushioned" on pressurized lubricant for instant, easy operation.



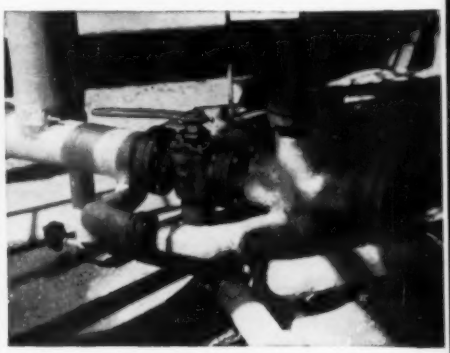
GAS SYNTHESIS

Where leakage is not only troublesome, but hazardous, you'll often see Rockwell-Nordstrom Hypreseal valves like the ones shown above. Pressurized lubricant in the sealing grooves acts like a *permanent soft seat* that is instantly replaceable.



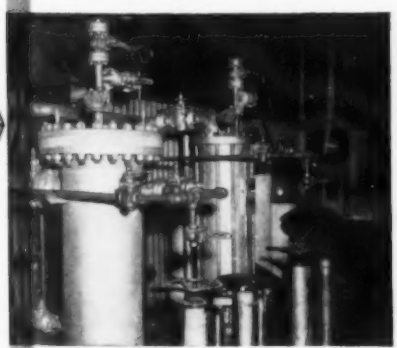
CATALYTIC POLYMERIZATION

On reactor effulent heat exchanger service (250 psig at 250° F) Rockwell-Nordstrom valves stay trouble-free month after month. Lubrication of valves on services like this is positive protection against costly valve failure. Rockwell-Nordstrom valves can be lubricated or adjusted while in service.



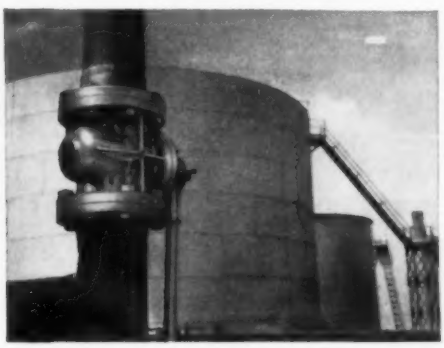
CAUSTIC REGENERATION

Tough services like sulphur removal are easy for Rockwell-Nordstrom valves. Seating areas are *never* exposed to the line and the tough film of lubricant insures a bottle-tight seal on services where other valves fail. Renewable lubricant can't wear out.



AMMONIA

The little (1") Rockwell-Nordstrom valves on the Ethylene and Methene service above do a big job of trouble-free, leakproof flow control. In any size, Rockwell-Nordstrom valves take less space and can be manifolded far tighter than ordinary valves.



STORAGE AND TRANSFER

Rockwell-Nordstrom valves will prove profitable throughout the transfer and storage system. Select from a *complete* line of valves and from a wide variety of operating accessories to answer your every flow control need. Positive shut-off stops product contamination and leakage hazards.

Refinery maintenance records all over the country prove that you can't make a better valve investment than Rockwell-Nordstrom. No matter what your valve requirements, there is a Rockwell-Nordstrom lubricated plug valve that will do the job better and at far lower cost. And they cost no more to buy, often less, than ordinary valves. Write today for complete details. Rockwell Manufacturing Company, Pittsburgh 8, Pa. Canadian Valve Licensee: Peacock Brothers Limited

ROCKWELL-Nordstrom VALVES

Lubricant Sealed For Positive Shut-off

A technician from our Instrument Division calibrates an M-S-A infrared process stream recorder against our master calibration panel.

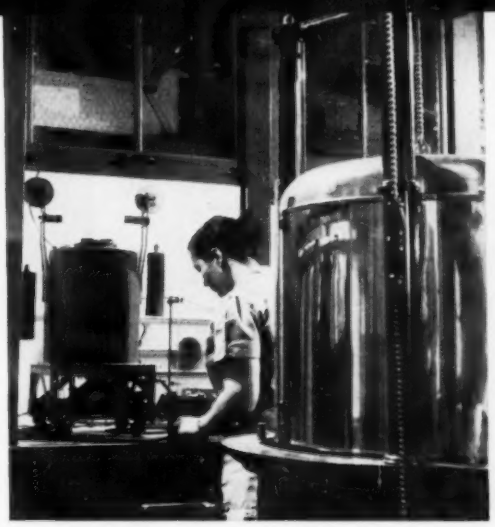
These special gas and vapor mixing fa

concentrations for accurate calibration o

We figure that accurate calibration of M-S-A instruments to customer sample specifications is a very necessary part of doing a good job in the process stream analyzer business. It's a company policy that started back about 30 years ago when we first got into gas analysis instrumentation.

From this long-time experience, we have developed a number of skills and a variety of unique methods for making known mixtures of gases and vapors. Some of our mixing techniques are pictured and described above. The products of these mixers are delivered to newly manufactured instruments. Calibration controls are then adjusted so that the recorder or indicator accurately reports the concentration. Normally, several mixtures are made for each instrument to check its performance throughout the scale range—both for accurately reporting the gas or vapor of interest—and to determine cross sensitivities to other components of the mixture. It all makes for a high degree of unerring dependability when an M-S-A analyzer is on stream.

We apply factory calibration to all of our instruments. Our basic units are shown at the right. These analyzers are ticking away throughout industry—improving product quality, lowering processing costs, and increasing safety. MSA is a good source to begin with if you have a process stream problem. Get in touch with us soon. Write to us for helpful literature or call in one of our Instrument Specialists for more information.



These gas holders contain synthesized mixtures which may be stored for delivery to instruments. The one at left is mercury sealed, the one at right is water sealed.

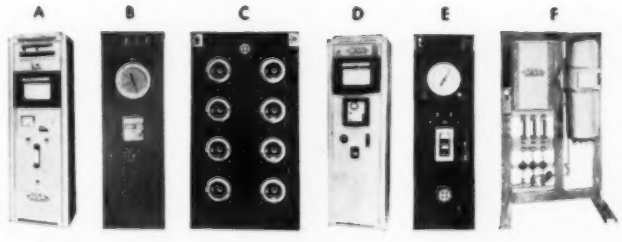
Technician above, is making a gas mixture from master panel flow meters, through which gas from several cylinders may be delivered simultaneously for calibration.

Here's still another calibrator in our stable of special mixing devices. This one is used for vaporizing liquid constituents in a gas stream.

Out on the assembly floor, an MSA engineer checks a process stream analyzer against customer sample that has been synthesized in a high pressure cylinder.

g facilities produce known

n of M-S-A® instruments



A. M-S-A (LIRA) Infrared Analyzer
B. M-S-A Hydrogen Sulphide Recorder
C. M-S-A Combustible Gas Analyzer
D. M-S-A Gas Thermatron
E. M-S-A Oxygen Indicator
F. M-S-A Water Vapor Recorder

INSTRUMENT DIVISION

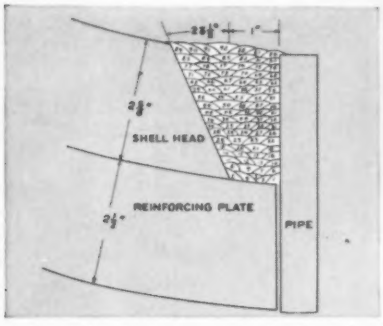
MSA

MINE SAFETY APPLIANCES COMPANY

Pittsburgh 8, Pennsylvania

All-welded reformer reactors, built by the Eddystone Division of B-L-H in the catalytic reforming unit of Tidewater Oil's Delaware refinery recently constructed by C. F. Braun & Co.

A 20-in. nozzle on the hemispherical head of one of the reactors is preheated prior to being welded in place.



Fusing 20-in. nozzle to a reactor head required 92 passes.

Baldwin whips tough task for oil industry . . . welds 100-ton vesssel of 13 kinds of steel 3/8 in. to 5 1/16 in. thick

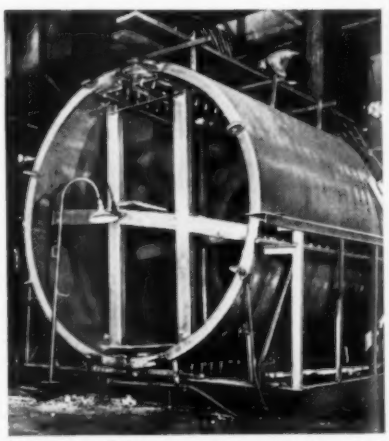
Big, unwieldy, complex, infinitely demanding – a really tough job in every sense of the word. But Baldwin-Lima-Hamilton's Eddystone Division was able to carry it out easily, economically. Ready on schedule, these two identical 100-ton reformer reactors are now producing high-octane components of aviation and motor gasolines at the Tidewater Oil Co.'s Flying A Refinery near Delaware City, Del.

Three welding methods–manual-shielded metal arc, automatic submerged metal arc, and inert gas–had to be used on these pressure vessels, which are 12 ft. in diameter and 20 ft. long. In order to minimize setup time and X-ray inspection costs, both vessels were fabricated simultaneously. As on all Baldwin work, only qualified welders were used.

The results of radiographic inspection of all welds convincingly attested to Baldwin's care and precision: no defects were found, no repair welding was necessary.

Both reactors must operate continuously for long periods of time at nearly 1000°F in a hydrogen-rich atmosphere at pressure up to 536 psi. Baldwin's highly creative fabricating skills have virtually guaranteed that they will.

For a copy of our illustrated Weldment Bulletin 7001, write to B-L-H Corporation, Philadelphia 42, Pa.



Automatic welding equipment mounted on platform above reactor cylinder is used for longitudinal seams, each requiring 64 passes.

BALDWIN · LIMA · HAMILTON

Eddystone Division

Philadelphia 42, Pa.

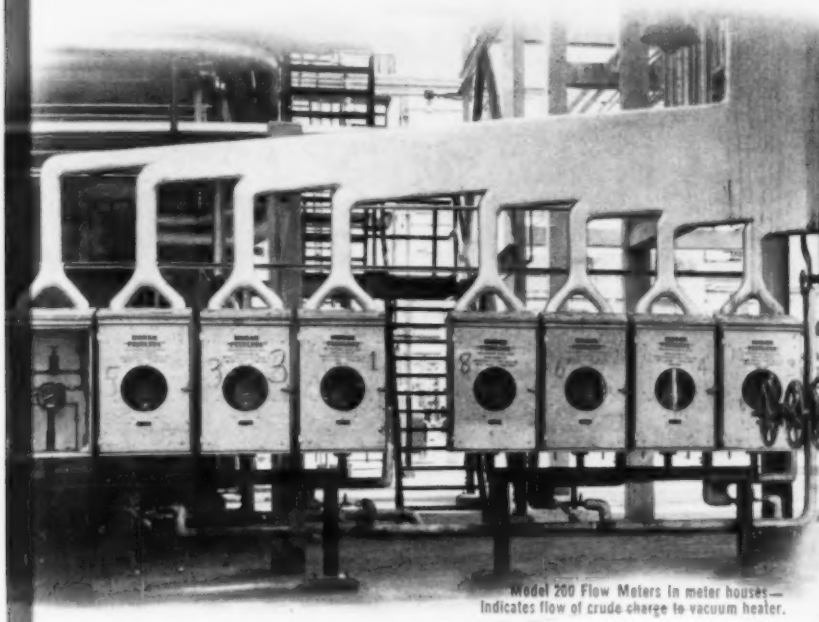
Hydraulic turbines • Weldments • Dump cars • Nonferrous castings

(To obtain more data on advertised products see page 230)

BARTONS working for TIDEWATER'S

DELAWARE

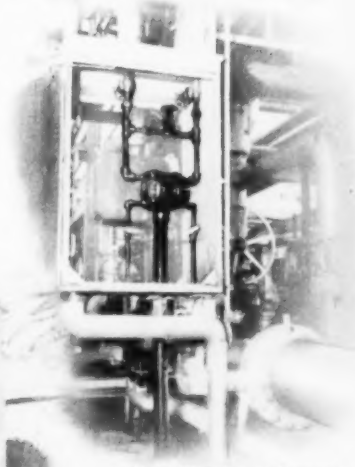
REFINERY



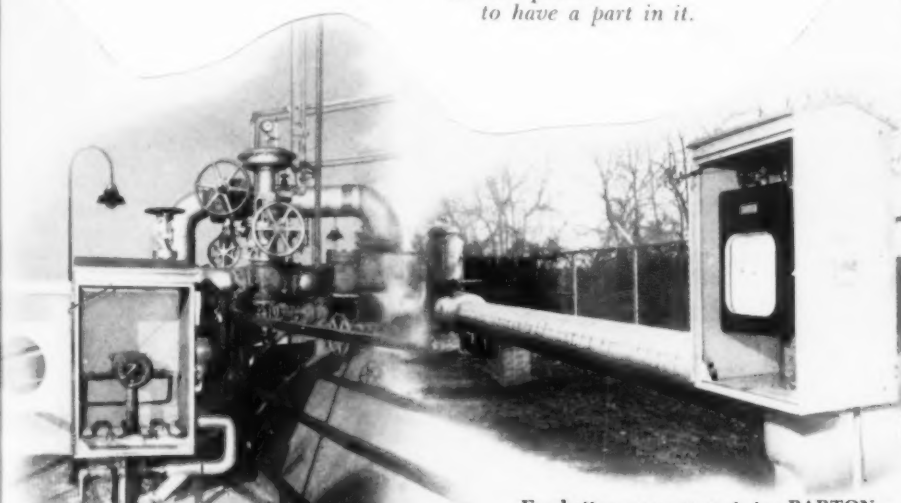
Model 200 Flow Meters in meter houses—
indicates flow of crude charge to vacuum heater.

Altering flow of crude charge
while observing change
on the indicators.

BARTON is pleased to have been selected
by Tidewater Oil Co., and C. F. Braun & Co.,
to work with them on the instrumentation of this modern Refinery.
Because of their constant zero and stable calibration
under varying temperatures and elevated pressures,
BARTON Differential Pressure Units were chosen
for use on all flows for accounting service.
In addition, units are being used on flow measurement
both for local visual operation and for transmission
to the Control Room to dictate to the central information,
logging and control systems which put into practice
the newest techniques
in process instrumentation.
We are proud
to have a part in it.



Model 199 Differential Pressure Unit
on Taylor Transmitter—
measures, indicates and transmits flow
of stripping steam to
cracker fractionating tower.



Model 202 Flow Meter—
records water flow from
remote well station.

Model 200 Flow Meter—
indicates flow of
snuffing steam to cyclone
at top cracker regenerator.

For better measurement, try BARTON – a complete line of rupture-proof bellows-type meter bodies, indicators, recorders, switches, transmitters, controllers and integrators for precise measurement of flow, liquid level and differential pressure.

BARTON INSTRUMENT CORPORATION

580 MONTEREY PASS ROAD, MONTEREY PARK, CALIFORNIA

100 pressure
90 temperature
400 flow
32 level

... *measurements are taken at Tidewater by Taylor Transmitters*

FOR what has been described as "the world's most modern refinery" near Delaware City, Tidewater Oil Company and their engineering constructors, C F Braun & Co., selected Taylor Transmitters for practically all temperature, pressure, flow, level and differential pressure measurement.

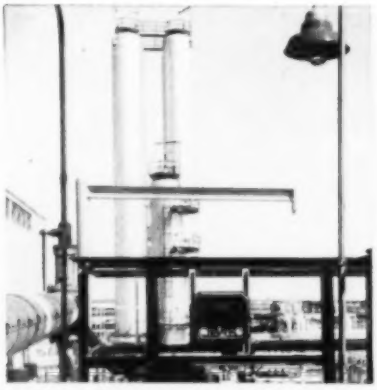
Measurement of these variables is critical from both an operations and economy standpoint, and we are proud of the fact that Tidewater considered the performance of Taylor Transmitters has justified their selection. Instruments required a minimum of adjustment in putting the refinery on stream. C F Braun & Co. engineers were impressed with the promptness of delivery of the original order as well as last minute requirements.

Reputation for Low Maintenance Big Factor

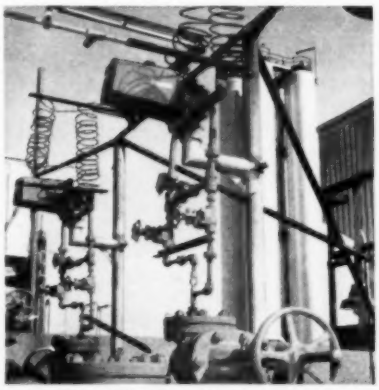
Taylor Transmitters have long enjoyed a reputation for low maintenance. A tour of other refineries where quantities of these instruments were being used, quickly confirmed the reports. Equally impressive are the design features permitting changes of range level or span for different operating conditions.

That Tidewater relied on Taylor for critical measurements to help protect their multi-million dollar investment is tribute indeed to the dependability, ruggedness and accuracy of these instruments.

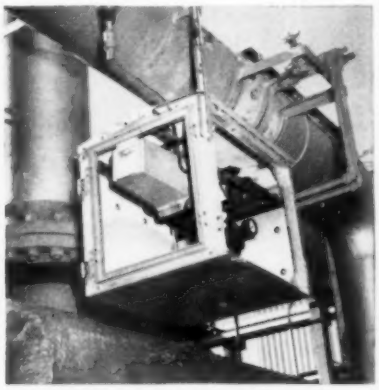
To find out how you can benefit from Taylor instrumentation, call your Taylor Field Engineer, or write Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.



Taylor 226R FULSCOPE* Indicating Pressure Transmitter applied to a debutanizer accumulator. The slightest deviation in pressure here would be detrimental to product specification.



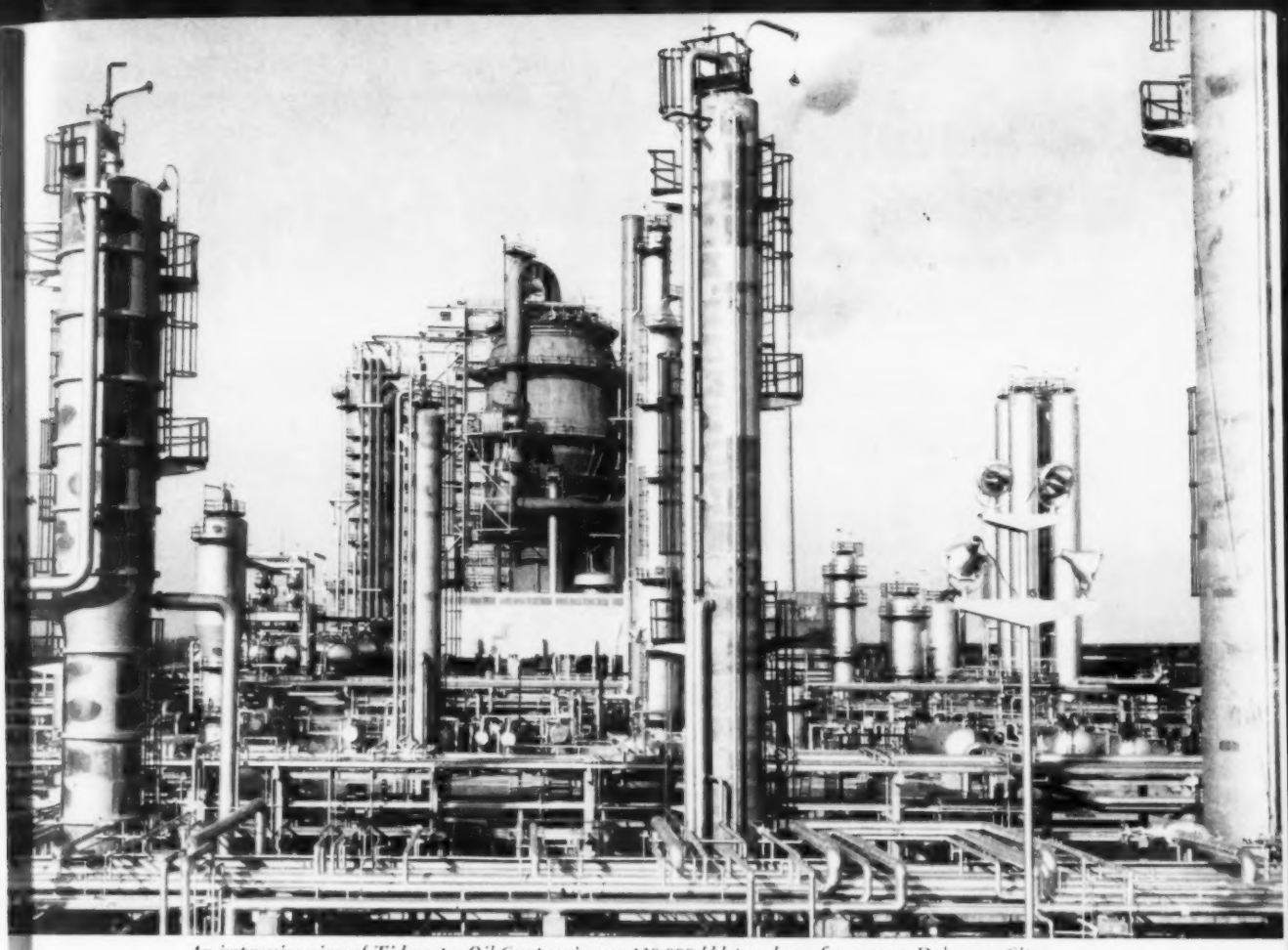
Taylor 333RD Flow Transmitters measuring the differential created by Pitot Venturi flow elements in parallel airflows responsible for carrying the catalyst to regeneration.



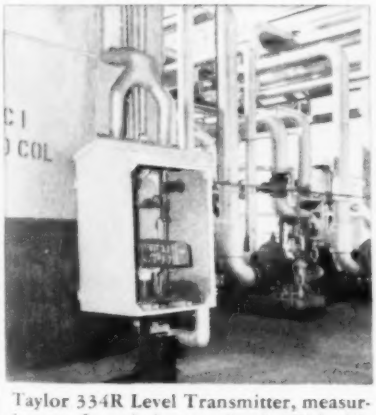
One of 400 versatile 333RD Flow Transmitters, measuring hydro-carbon vapors. Here, as in all other refinery applications, rugged dependability is especially appreciated.

Taylor Instruments

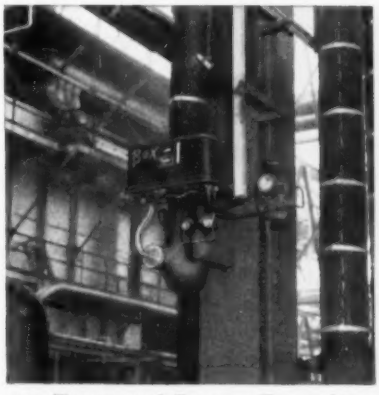
(To obtain more data on advertised products see page 230)



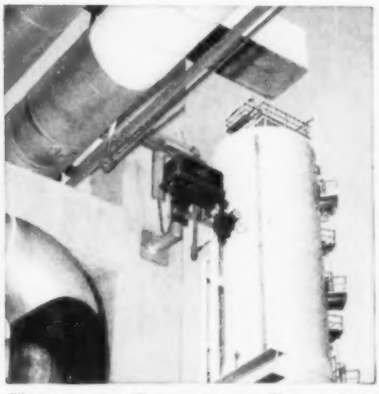
An impressive view of Tidewater Oil Company's new 130,000 bbl. per day refinery near Delaware City



Taylor 334R Level Transmitter, measuring crude unit bottom level. With this instrument increasing levels give increasing pneumatic signals even though sealing legs are used.



100 TRANSAIRE* Pressure Transmitters are used where close pressure control is essential. The suppressed narrow span permits accuracies not possible with conventional instruments.



TRANSAIRE Temperature Transmitter on the crude unit, responsible for first fractionation of the crude as it enters the refinery. Note that the instrument is exposed to the elements.

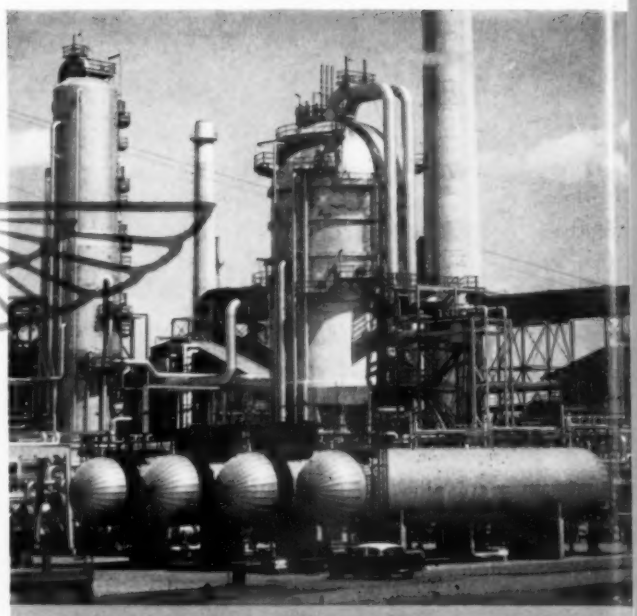
*Reg. U.S. Pat. Off.

VISION • INGENUITY • DEPENDABILITY

MEAN ACCURACY FIRST

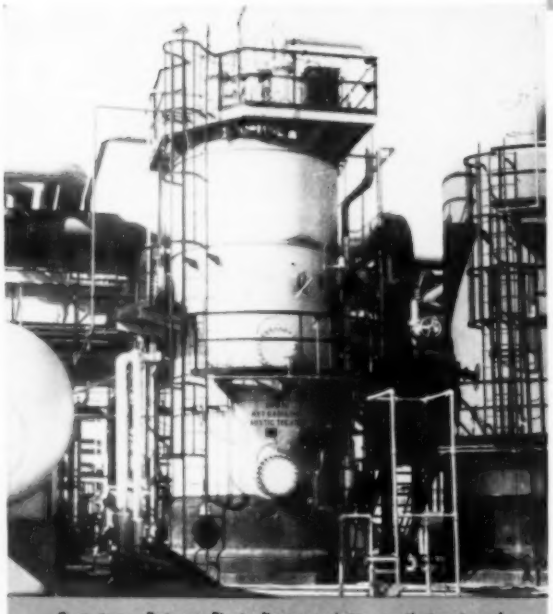
(To obtain more data on advertised products see page 230)

again at ***TIDEWATER***



The Petreco Desalter in the foreground of the above photo was designed to desalt extremely salty crude to a very low salt content.

PETRECO
ELECTRIC DESALTING



Two-stage Petreco Electrofiner used to caustic-treat and water-wash a heavy gasoline stream. Note the compactness of the unit and the small space it occupies.

AND PETRECO ELECTROFINING *are specified*

At Tidewater Oil Company's new Delaware Refinery the emphasis was definitely on *the best.* The equipment and processes used were specified with one primary objective—to create the finest, most modern refinery in the world.

Petreco feels that the specification of Petreco Electric Desalters for crude charge purification, and Petreco Electrofining for heavy gasoline caustic treating, is particularly significant.

Like other leading refiners all over the world, when Tidewater wanted the best, they specified Petreco.

PETRECO

A DIVISION OF PETROLITE CORPORATION

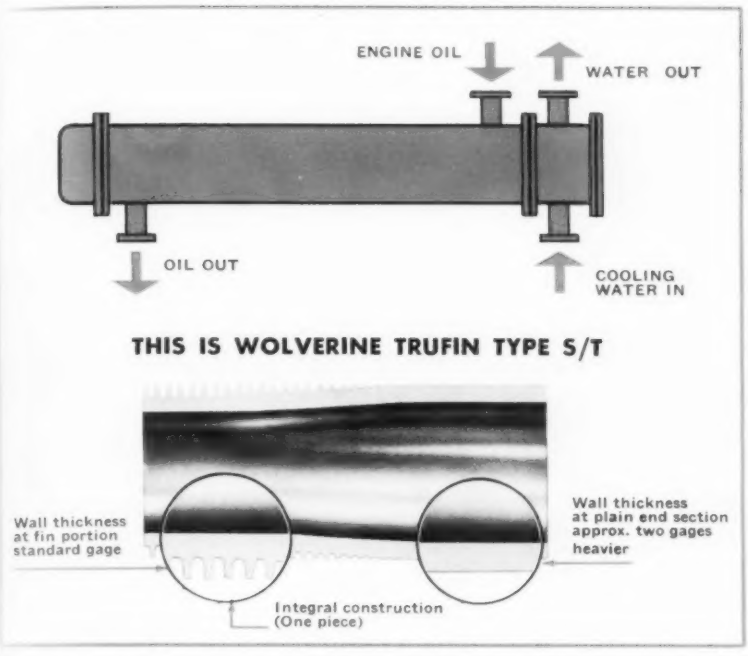
3202 S. WAYSIDE DRIVE, HOUSTON 1, TEXAS • 1390 EAST BURNETT STREET, LONG BEACH 7, CALIFORNIA

PTW-57-1

Specialized Electric Petroleum Treating

DESALTING • DEHYDRATING • CAUSTIC WASHING • ACID TREATING • DOCTOR TREATING • SWEETENING • NAPHTHENIC ACID REMOVAL • SEDIMENT REMOVAL

(To obtain more data on advertised products see page 230)


ENGINE OIL
WATER OUT
OIL OUT
COOLING WATER IN
THIS IS WOLVERINE TRUFIN TYPE S/T
Wall thickness at fin portion standard gage
Wall thickness at plain end section approx. two gages heavier
Integral construction (One piece)

Trufin-Tubed Engine Oil Cooler Provides Maximum Performance—Minimum Upkeep

BY ERNEST DODD

Most of the time, cooling engine oil is the kind of job refinery men would just as soon do without. In most cases it's a dirty service — requires frequent cleaning of tube bundles and, because it is primarily a maintenance cost item — it doesn't produce a profit.

But like it or not—it has to be done —and here are the details of how engineers in a Texas refinery have removed much of the difficulty usually encountered in this type of work.

Four years ago, this firm put in service a heat exchanger tubed with 172 eight-foot lengths of Wolverine Trufin®—Type S/T—the integrally finned condenser tube. This exchanger operates next to identical units tubed with prime surface tube.

In the intervening years, the Trufin unit has cooled the engine oil to the desired temperature without difficulty. Although the service is regarded as dirty on the shell side, this Trufin-tubed exchanger has outperformed the bare tube units — has remained on stream three to four times longer before cleaning was required. The reduction in maintenance because of this has been substantial and has resulted in welcome savings.

The ability of Trufin Type S/T to take fouling in its stride is well substantiated. Engineers have discovered that the configuration of Trufin's extended surface is apparently less conducive to scale build up than that of plain tube. Scaling tends to follow the contour of the fins and does not accumulate preferentially between the fins, instead the scaling forms an extended projection of the fin. In many cases Trufin appears to be self shedding.

In this particular refinery, engineers are so pleased with the results on engine oil coolers that as each cooler requires retubing the prime surface tubes are being replaced with money-saving, performance-boosting Wolverine Trufin Type S/T — the condenser tube with the integral fins.

TYPE S/T HAS 150% THE SURFACE OF PLAIN TUBE

Big statement?

No siree — just the plain unvarnished truth. Wolverine Trufin Type S/T — the integrally finned condenser tube— has approximately 1½ times—or 150% — more surface area than a piece of plain tube of equivalent length and diameter. In addition it has an external to internal surface ratio of 3½ to 1.

Trufin Type S/T cannot be used indiscriminately in all heat exchanger applications with economic advantage. BUT —if your heat exchanger operations include any of the following (to name but a few) those are mighty important figures — the kind that can help you achieve big increases in heat transfer performance:

1. Condensing Freon and other refrigerants.
2. Condensing hydrocarbons.
3. Condensing organic chemicals.
4. Evaporating Freon—water chillers.
5. Boiling hydrocarbons.
6. Heating or cooling gases.
7. Heating or cooling lube oils, transformer oils, absorber oils and quench oils.

And that isn't all.

Wolverine Trufin Type S/T is equally effective in both old and new equipment. In new equipment, Trufin Type S/T permits you to design smaller, more powerful units — with a consequent savings in direct tube costs, as well as in smaller shells, heads, baffles and labor, etc. If the units are to be used in overhead service there is also a substantial saving in weight which in turn means lighter superstructures.

When retubing existing equipment, Trufin Type S/T permits you to pack more heat transfer surface into a given area — steps up the capacity of your present exchangers and condensers.

Next time you're considering new equipment—or retubing old—remember Wolverine Trufin Type S/T. It can be your key to greater heat transfer efficiency with greater economy.

SEND FOR FREE BOOK

Wolverine's Condenser Tube Catalog contains much valuable information concerning alloys, corrosion, types of tube, tubing applications, etc. Write— today—for your free copy.

Wolverine Trufin is available in Canada, through the Unifin Tube Company, London, Ontario.

CALUMET & HECLA, INC.
CALUMET DIVISION
WOLVERINE TUBE DIVISION
FOREST INDUSTRIES DIVISION
GOODMAN LUMBER COMPANY
CALUMET & HECLA OF CANADA LIMITED
CANADA VULCANIZER AND EQUIPMENT COMPANY LIMITED

WOLVERINE TUBE

Division of Calumet & Hecla, Inc.
1441 CENTRAL AVE. DETROIT 9, MICH.

PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES.
EXPORT DEPARTMENT, 11 EAST 40TH STREET, NEW YORK 16, NEW YORK

WRITE FOR THIS FREE FOLDER —

It's Valuable

WOLVERINE
CORROSION CHART
WOLVERINE TUBE
Division of Calumet & Hecla, Inc.
Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes
GENERAL SALES OFFICES
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The corrosive actions of hu
dreds of various substanc
on copper and copper allo
and, in some cases, on iro
steel and aluminum a
described in the Wolver
Corrosion Chart. This fol
can serve as a valuable ref
ence file for processing a
refining engineers. To ge
copy free, fill in and mail t
coupon below. Do it today!

Please send me the Wolverine Corrosion Cha

NAME _____

TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE ____ STATE ____

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SALES OFFICES IN PRINCIPAL CITIES.

EXPORT DEPARTMENT, 13 EAST 40TH STREET, NEW YORK 16, NEW YORK

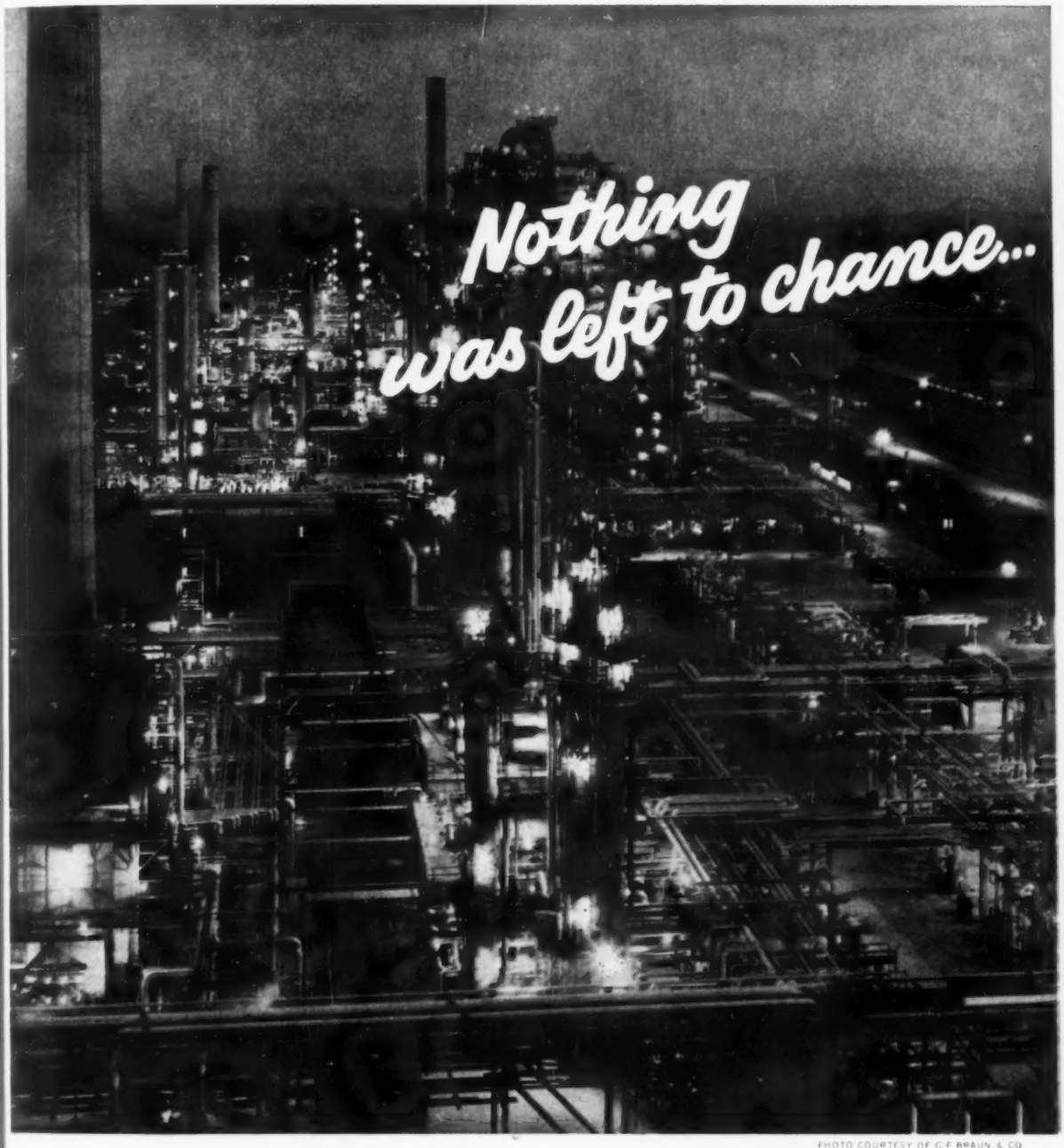


PHOTO COURTESY OF C.F. BRAUN & CO.
ENGINEERS AND CONSTRUCTORS

PACIFIC PUMPS INC was selected to supply practically 100% of TIDEWATER'S centrifugal process pumps for their new DELAWARE REFINERY

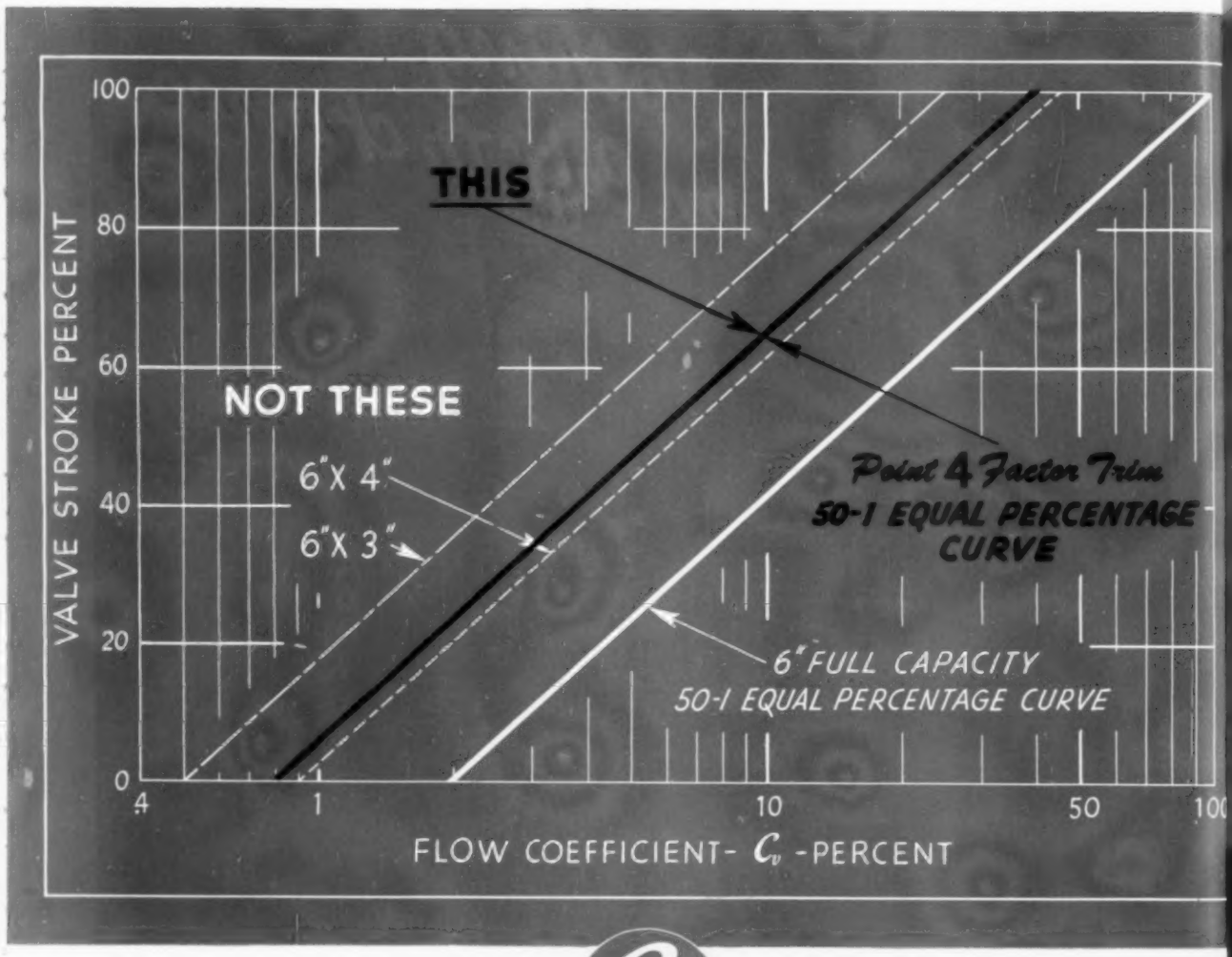
Pacific's world-wide reputation for engineering pumps with outstanding performance and service records was further evidenced by Tidewater's choice. We are justly proud of this opportunity to put more Pacific pumps to work for Tidewater at Delaware as we have at their Avon, California refinery. It is our feeling that our excellent pump service engineering staff (always available when needed, anywhere, anytime) also influenced their decision. Whatever your pumping requirements—it will pay you to consult Pacific.

PACIFIC

PACIFIC PUMPS INC.
HUNTINGTON PARK, CALIFORNIA
Offices in all Principal Cities

CP-17

One Size...



A HIGH Quality Coefficient C_Q PRODUCT

Point 4 Factor Trim

is the answer to those few types of applications where reduced capacity trim is required. It is available in V-port and solid turned designs for double or single seated valves and in a wide variety of materials. Send for Data Sheet No. 10-5.

Not Two

Masoneilan *Point 4 Factor Trim* offers the ONLY REALISTIC approach to selection of reduced capacity trim

It is a DEMONSTRABLE Fact that for a given size top-and-bottom guided valve only *one* size reduced capacity trim is:

Desirable from an engineering standpoint because . . .

(a) properly designed wide-range valves with full capacity trim will handle a vast majority of control problems.

(b) if any reduction is required, it must be substantial to be of any advantage.

(c) any sound design must be based on a reduction in seat ring diameter.

(d) rule-of-thumb trim reductions based on nominal *pipe* sizes are unnecessary and merely complicate the sizing problem.

Practical from manufacturing and operating standpoint because . . .

(a) mechanical strength is retained with standard guide and stem diameters and standard stroke, in combination with maximum reduction in seat diameter.

(b) reduction in number of parts simplifies stock problem.

(c) forged and cast forms insure complete uniformity of parts.

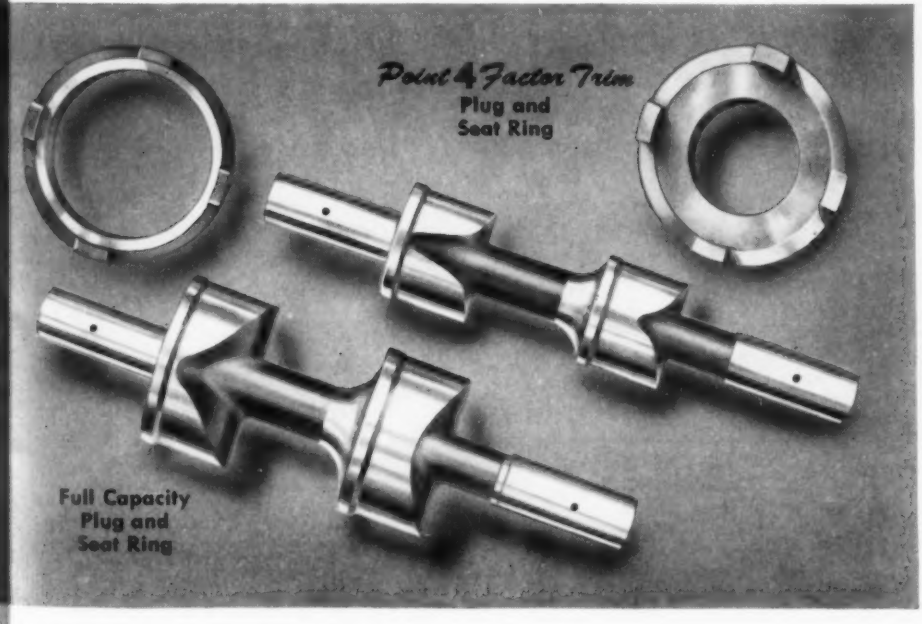
MASONEILAN

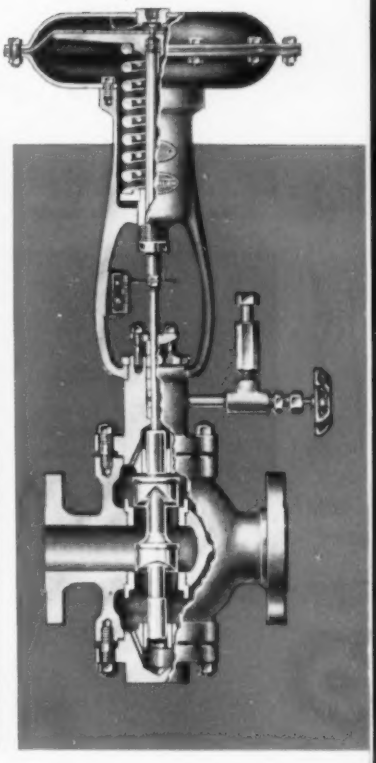
MASON-NEILAN

Division of Worthington Corporation

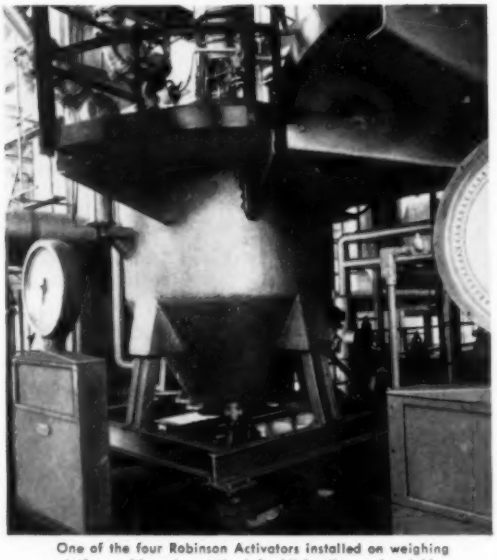
49 NAHATAN STREET, NORWOOD, MASSACHUSETTS

Sales Offices or Distributors in the Following Cities: New York • Syracuse • Chicago • St. Louis Tulsa • Philadelphia • Houston • Pittsburgh • Atlanta • Cleveland • Cincinnati Kansas City • Phoenix • Detroit • San Francisco • Louisville • Salt Lake City • El Paso Albuquerque • Charlotte • Los Angeles • Corpus Christi • Denver • Appleton • Birmingham New Orleans • Dallas • Seattle • Mason-Neilan Regulator Co., Ltd., Montreal and Toronto





Robinson CONVEYS TIDEWATER'S FLUID COKE



One of the four Robinson Activators installed on weighing platform with scales at the left. All loading and weighing operations are automatic. Batch weighing very accurate.

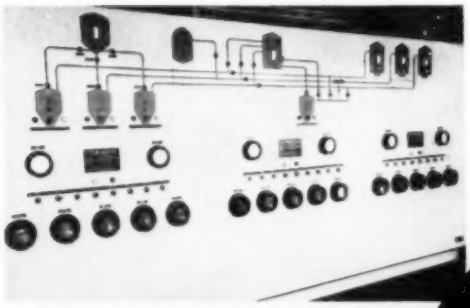
The Fluid Coker at Tidewater's immense new Delaware Refinery is the largest of its kind yet installed. Its final end-product is fluid coke —small hard beads of almost pure carbon— which is produced at the continuous design rate of 75 tons-per-hour, around the clock, around the year.

This fluid coke — at 350° F — has to be conveyed about 1500 feet from the Coker to a powerhouse of Delaware Power and Light where it is burned under three boilers.

Tidewater and the C. F. Braun Company, who engineered and built the refinery, had to be sure of selecting the most reliable means of conveying this coke, because any conveying failure would cause a serious shutdown of the Coker and at the same time force the powerhouse to switch to more costly fuels.

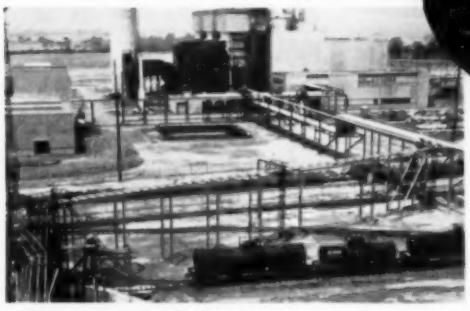
Robinson Air-Activated Conveying Systems were selected for this important task only after the most meticulous study of *all* conveying methods.

Robinson Systems are also in use in refineries all over the world for the economical and trouble-free conveying of catalysts and filter clays. One system conveys catalyst 2500 feet from railcar to cracker, including a vertical rise of 300 feet.



Control panel providing complete automatic operations.

1500 FEET AT 75 TONS-PER-HOUR



View of power plant in distance with the Robinson System Conveyor lines leading to it.

Our Bulletin and Job Data Sheet will give full details. Write for copies.

ROBINSON Air-Activated CONVEYOR SYSTEMS

A Division of Morse Boulger Destructor Co.

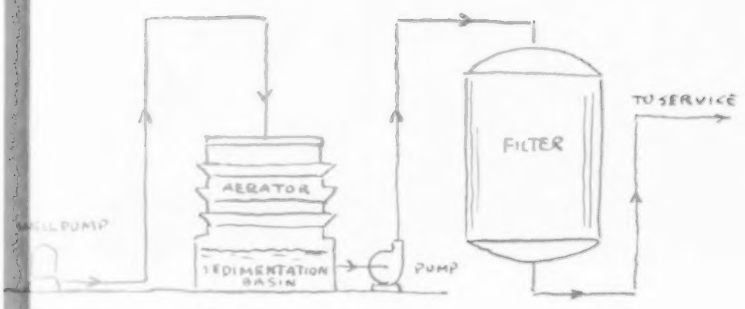
DEPT. V. 80 FIFTH AVENUE • NEW YORK 11, N. Y.

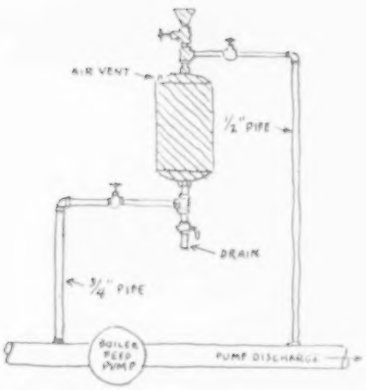
Representatives in Principal Cities

(To obtain more data on advertised products see page 230)

$$Ca^{++} + Na_2Z = CaZ + 2Na^{+}$$

347832
3.06
2086992
10434960
10064365.92





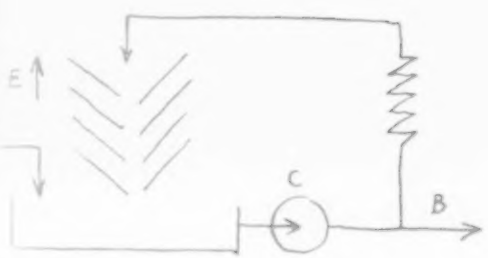
$$= \frac{18.5D^2(S_1 - S_2)}{Z}$$

$$= KC^{1/n}$$

any way you figure it,

the best solution to your

water problems is . . .



BETZ LABORATORIES INC., Philadelphia 24, Pa.

MODERN BUSINESS

AND MODERN SCHOOLS

NEED EACH OTHER MORE THAN EVER!

This has been a great year! America is building and replacing and thus moving faster than ever before.

Only one thing. Will the labor market keep pace? That's where schools are important. If your company isn't helping community groups to get modern schools, it's not apt to get the skilled people it needs. Self interest, civic spirit, or both, you should make schools your business, too.

PUBLIC SERVICE · ADVERTISING COUNCIL

Want to find out how to help in *your* community?
Get specific information by writing:
Better Schools, 9 East 40th Street, New York, N. Y.

A PRIME OUTLET FOR GOOD PUBLIC RELATIONS

and a desperately-needed public service

One of the most effective public relations jobs ever accomplished was achieved last year by hundreds of companies and individual businesses of every size.

These companies have been helping to sustain an advertising campaign that performs a desperately-needed public service: It shows the American people how to drive to stay alive. It also portrays the almost unbelievable fact that more than 40,000 men, women and children were killed in traffic accidents last year—and tells what to do to help stop highway homicide.

The campaign was prepared by a volunteer advertising agency in cooperation with The Advertising Council and The National Safety Council. But the over ten million dollars worth of time and space which carry the messages to the public was contributed by media owners or sponsored by business organizations, in the public interest.

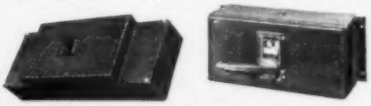
Your own plans may readily permit the inclusion of such advertising—both from the view of the vital public service it would perform, and the incalculable good will it would promote for your name, your company, and your product or service.

To find out how easily your own program can tie in with this nationwide effort, and for the complete story on who, what, when and where, we sincerely invite you to write to The National Safety Council, Chicago 11, Illinois.

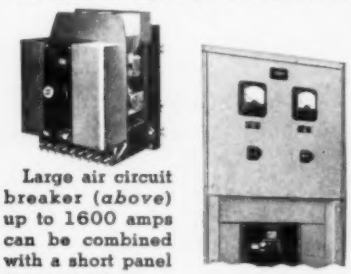
Published in cooperation with
The National Safety Council
The Advertising Council

SQUARE D's NEW Unit Substation IN POWER-STYLE CONSTRUCTION

Designed to match Square D's Power-Style switchboards and control centers, these new Unit Substations meet NEMA, ASA, and AIEE standards. Available from 75 to 500 KVA; in primary voltages up to 4800V; secondary up to 600V.



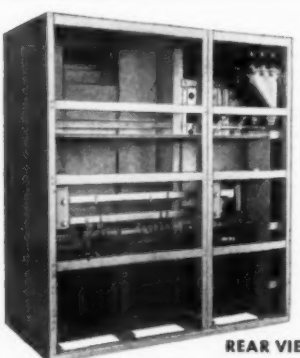
Molded case circuit breakers (*left*) up to 800 amperes and QMB Saflex fusible switches (*right*) up to 600 amperes are available in compact panel construction.



Large air circuit breaker (*above*) up to 1600 amps can be combined with a short panel in one section.

Pothead | Interrupter Switch | Cutout

Potheads, fused or unfused load break air-interrupter switches and fused or unfused oil-filled cutouts are available. Air-interrupter switches and cutouts are easily accessible from front of Substation.



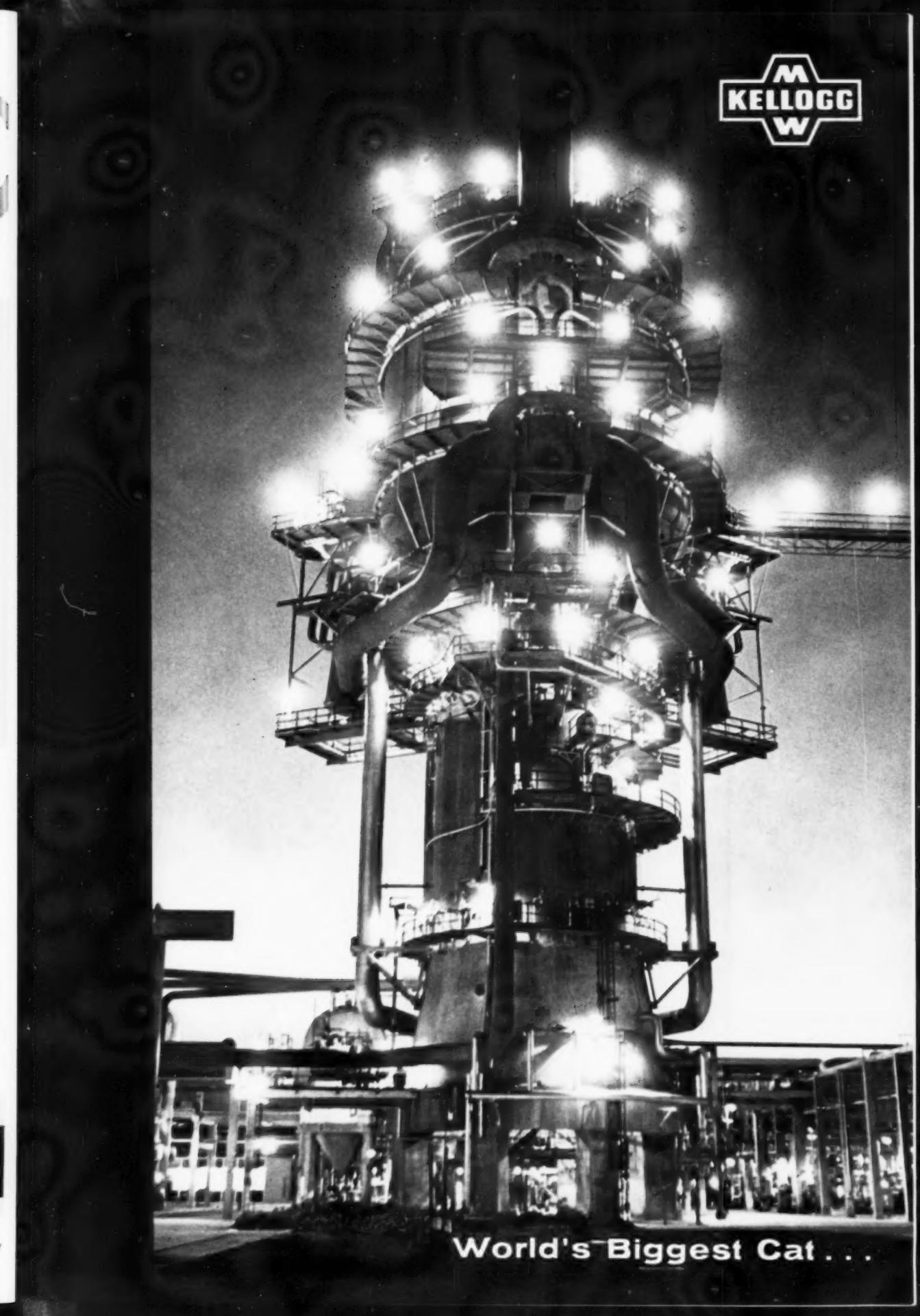
REAR VIEW

3 single phase, dry-type transformers individually mounted on base in ventilated enclosure—heating and vibration held to a minimum. Transformers easily accessible for maintenance and inspection. When no air circuit breaker or metering equipment is used, entire area at top left is available for pull box.

NOW...EC&M PRODUCTS ARE A PART OF THE SQUARE D LINE!

SQUARE D COMPANY

(To obtain more data on advertised products see page 230)


M
KELLOGG
W
World's Biggest Cat . . .

. . Tidewater Oil Company's New

Orthoflow®

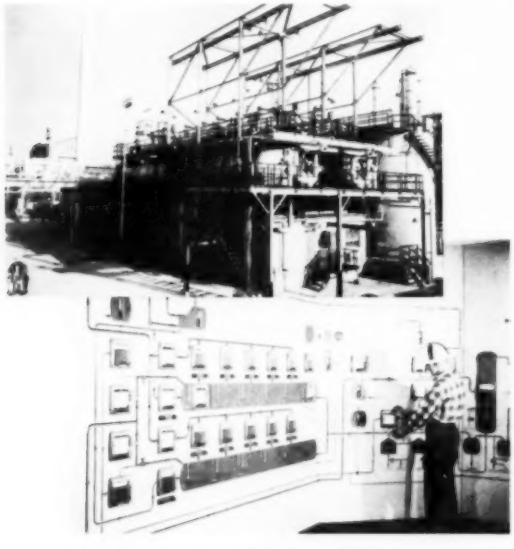
FLUID CATALYTIC CRACKER

developed and engineered

by The M. W. Kellogg Company

A throughput capacity of 102,000 BPD makes the Orthoflow Fluid Catalytic Cracking Unit, shown here and on the preceding page, the largest in the world. Engineered by The M. W. Kellogg Company for Tidewater Oil Company's Delaware Refinery, south of Wilmington, this Orthoflow is the culmination of Kellogg's experience in engineering 66 fluid catalytic cracking units throughout the world, of which 16 are Orthoflow units.

Kellogg welcomes the opportunity of demonstrating to other refiners, as it did for Tidewater, the numerous advantages of the Orthoflow design.



Kellogg Also Developed and Engineered Tidewater's Sulphuric Acid Alkylation Unit

With a design capacity of 5,000 BPD of alkylate, and a potential capacity of 9,000 BPD, Tidewater's alkylation unit at the Delaware Refinery is one of the largest in operation. Interior view shows controls for the two 5-stage reactors.

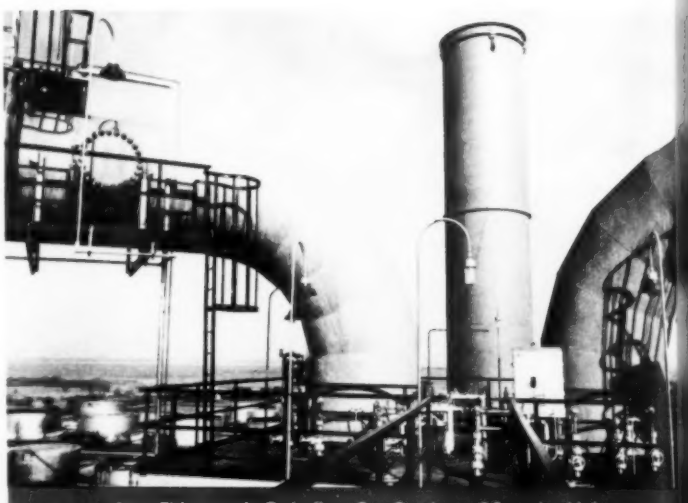
Refinery Process Division

The M. W. Kellogg Company

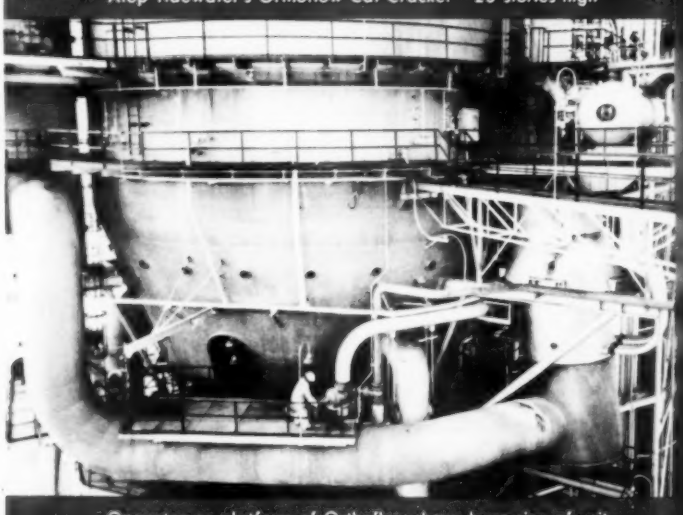
711 Third Avenue, New York 17, N. Y.

A SUBSIDIARY OF PULLMAN INCORPORATED

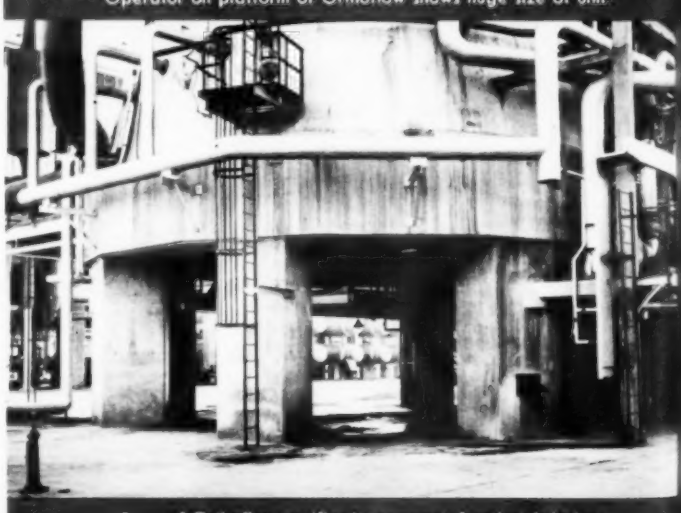
The Canadian Kellogg Co. Ltd., Toronto • Kellogg International Corp., London
Kellogg Pan American Corp., New York • Societe Kellogg, Paris • Companhia Kellogg Brasileira, Rio de Janeiro • Compania Kellogg de Venezuela, Caracas



Atop Tidewater's Orthoflow Cat Cracker—25 stories high



Operator on platform of Orthoflow shows huge size of unit

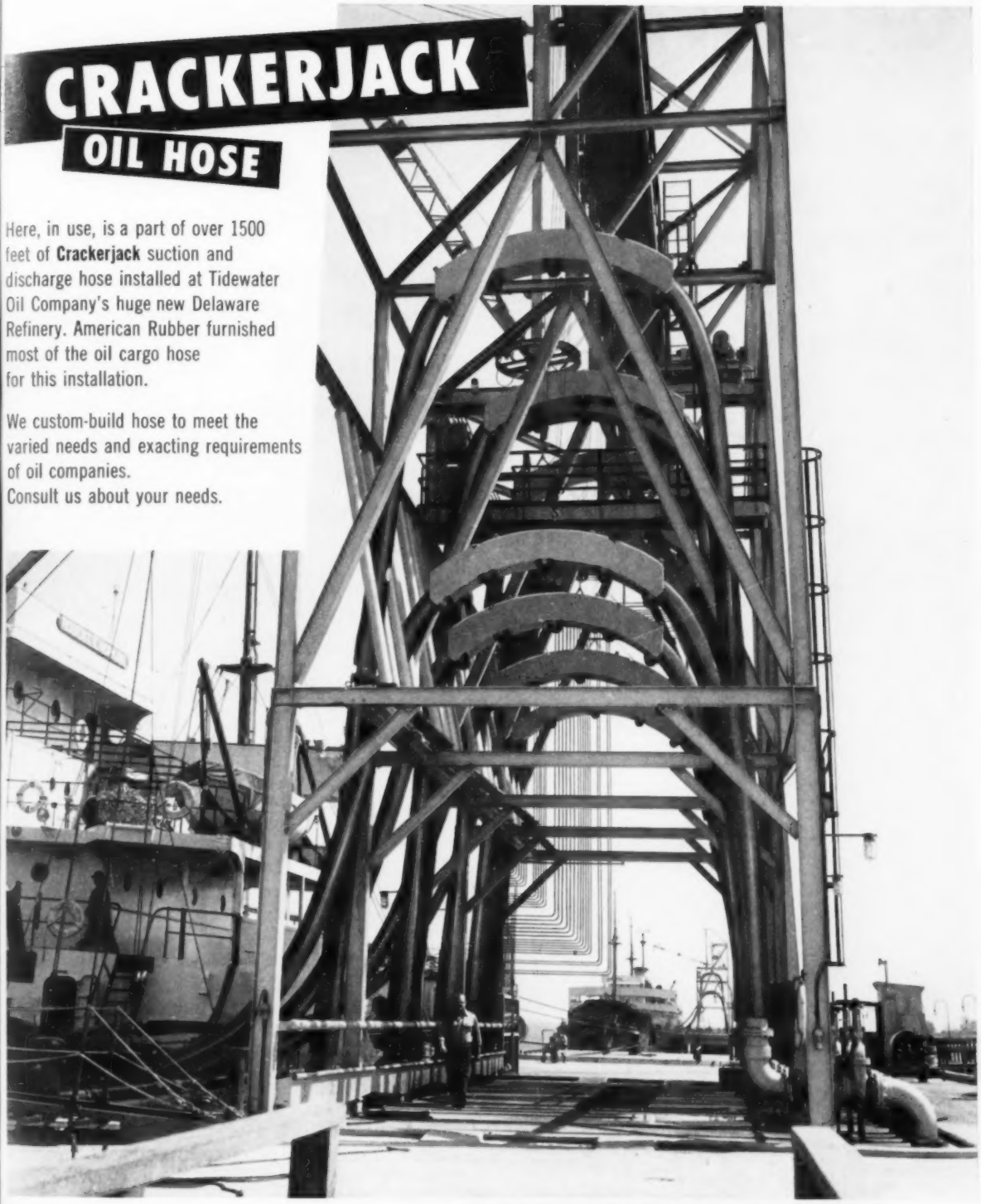


Base of Orthoflow typifies its compact, functional design

CRACKERJACK
OIL HOSE

Here, in use, is a part of over 1500 feet of **Crackerjack** suction and discharge hose installed at Tidewater Oil Company's huge new Delaware Refinery. American Rubber furnished most of the oil cargo hose for this installation.

We custom-build hose to meet the varied needs and exacting requirements of oil companies.
Consult us about your needs.



Custom builders of top quality hose and belting since 1906

THE American RUBBER MANUFACTURING CO.

AR-42

Factory & General Offices: 1145 Park Avenue • Oakland 8, California • Phone OLympic 2-0800

SEATTLE • PORTLAND • SAN FRANCISCO • LOS ANGELES • BOISE • ST. LOUIS • SALT LAKE CITY • HOUSTON • NEW ORLEANS

(To obtain more data on advertised products see page 230)

CONSOTROL* RECORDING

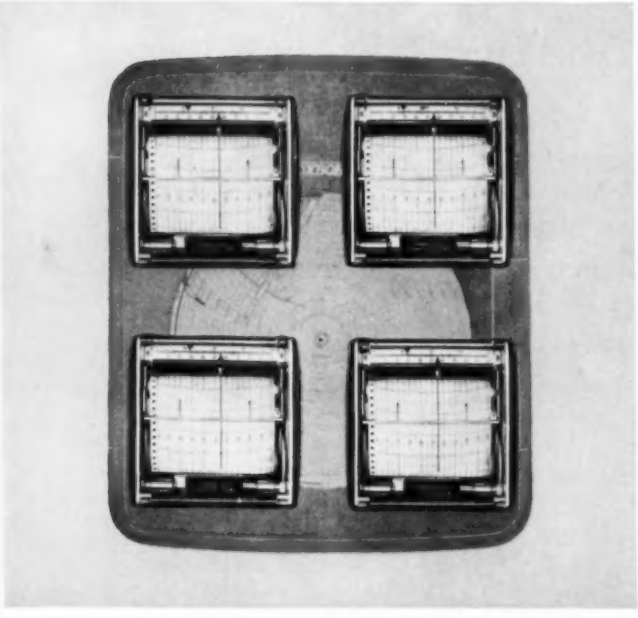
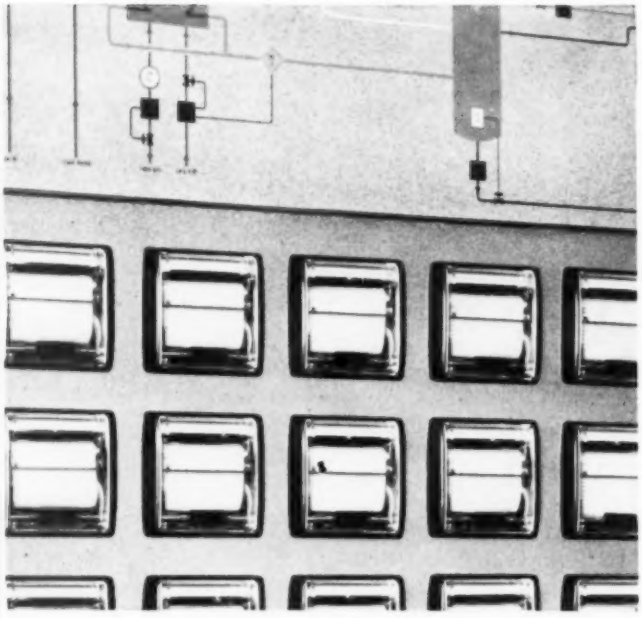


Illustration shows how 4 Consotrol Instruments require less panel space than does a single, conventional 12" recorder.



Typical control panel showing Consotrol Recording Control Stations. Associated M/58 Controllers, integrally mounted, pull out with the recorders.

The ORIGINAL small-case control panel instrument with a FULL SCALE 4 INCH CHART.

Full-scale *readability!* Here is the industry standard set by Consotrol Instruments, with no compromise in compactness, convenience, or performance.

These Recorders and Recording Control Stations are so compact you can actually mount 4 in the space required by 1 standard 12-inch recorder. And yet, inside the case, all components are full size — nothing is "miniature."

With the integrally mounted Model 58 Controller, the Foxboro Consotrol Recording Control Station provides precise, dependable control and full-scale chart records in one-quarter the panel space. Maintenance is easier too, with all calibration adjustments made from the front . . . re-inking needed only twice a year . . . chart changes as seldom as once a month.

For the complete story, write for Bulletin 13-18. **The Foxboro Company, 917 Neponset Avenue, Foxboro, Massachusetts, U.S.A.**

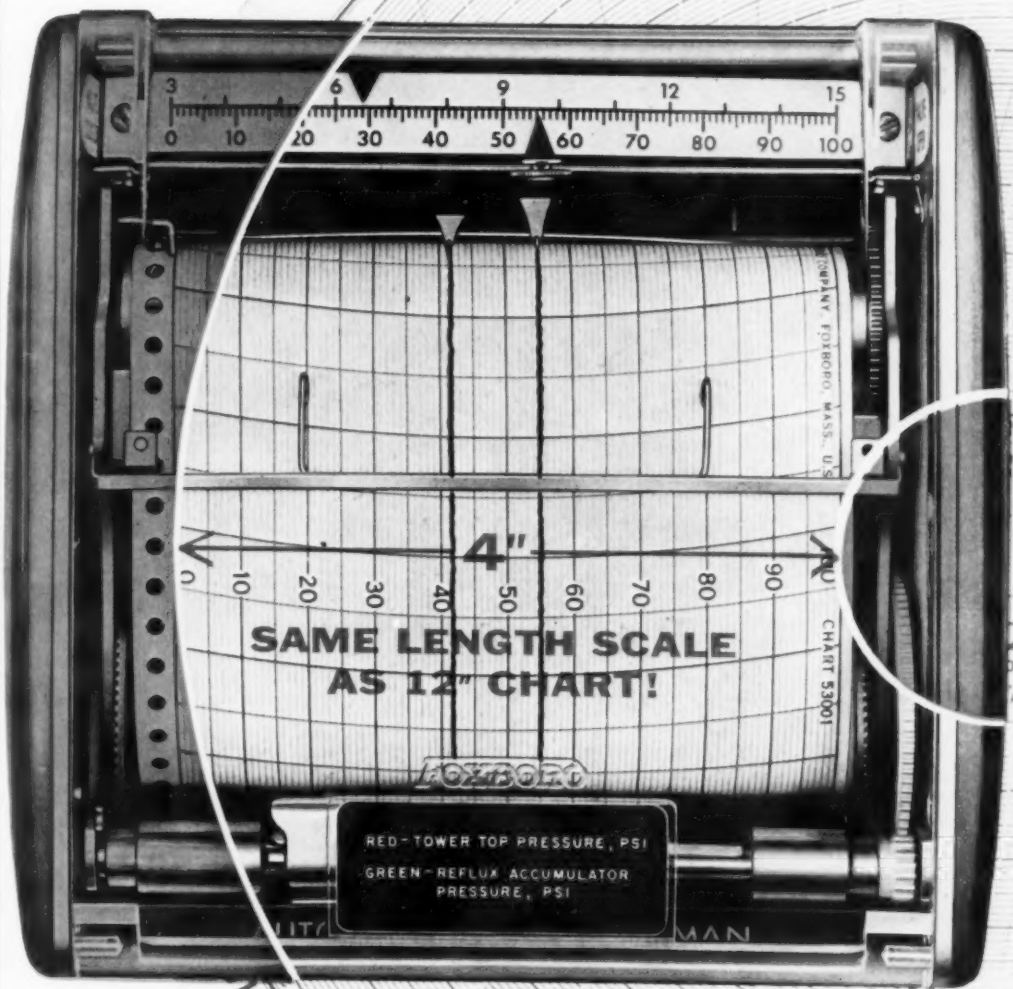
INTRODUCED IN 1952 — OVER 25,000 NOW IN USE

*Reg. U.S. Pat. Off.

FOXBORO

REG. U.S. PAT. OFF.

CONTROL STATION

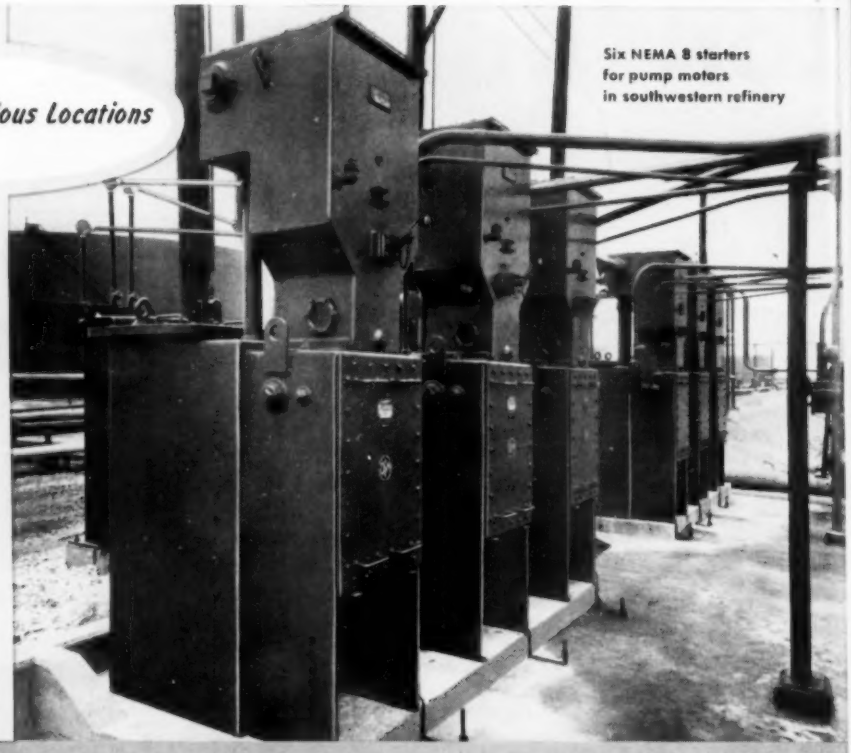


ACTUAL SIZE illustration of Consotrol Instrument super-imposed on standard 12-inch chart. Note full 4" wide strip chart has same length scale as 12" circular chart.

CONSOTROL INSTRUMENTS

RECORDING · CONTROLLING · INDICATING

for Class 1, Group D, Hazardous Locations

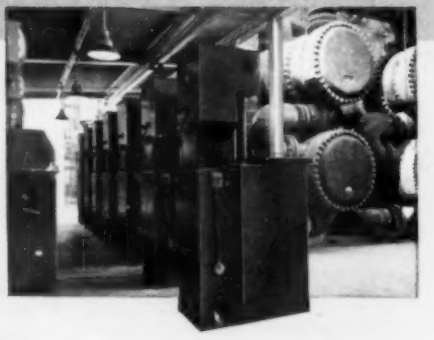


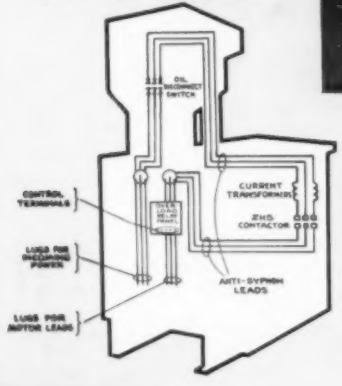
Six NEMA 8 starters for pump motors in southwestern refinery

here's how to

SAVE SPACE and INSTALLATION TIME with EC&M HIGH VOLTAGE STARTERS

SPACE SAVERS! Each of the seven starters in the eastern refinery installation *(at the right)* requires a space of only 2 ft. x 4 ft.—permitting close grouping with maximum accessibility for inspection and maintenance.





YOU SAVE INSTALLATION TIME because every EC&M starter is shipped with all internal wiring complete. *(See diagram at left)* All leads are of anti-syphon construction.

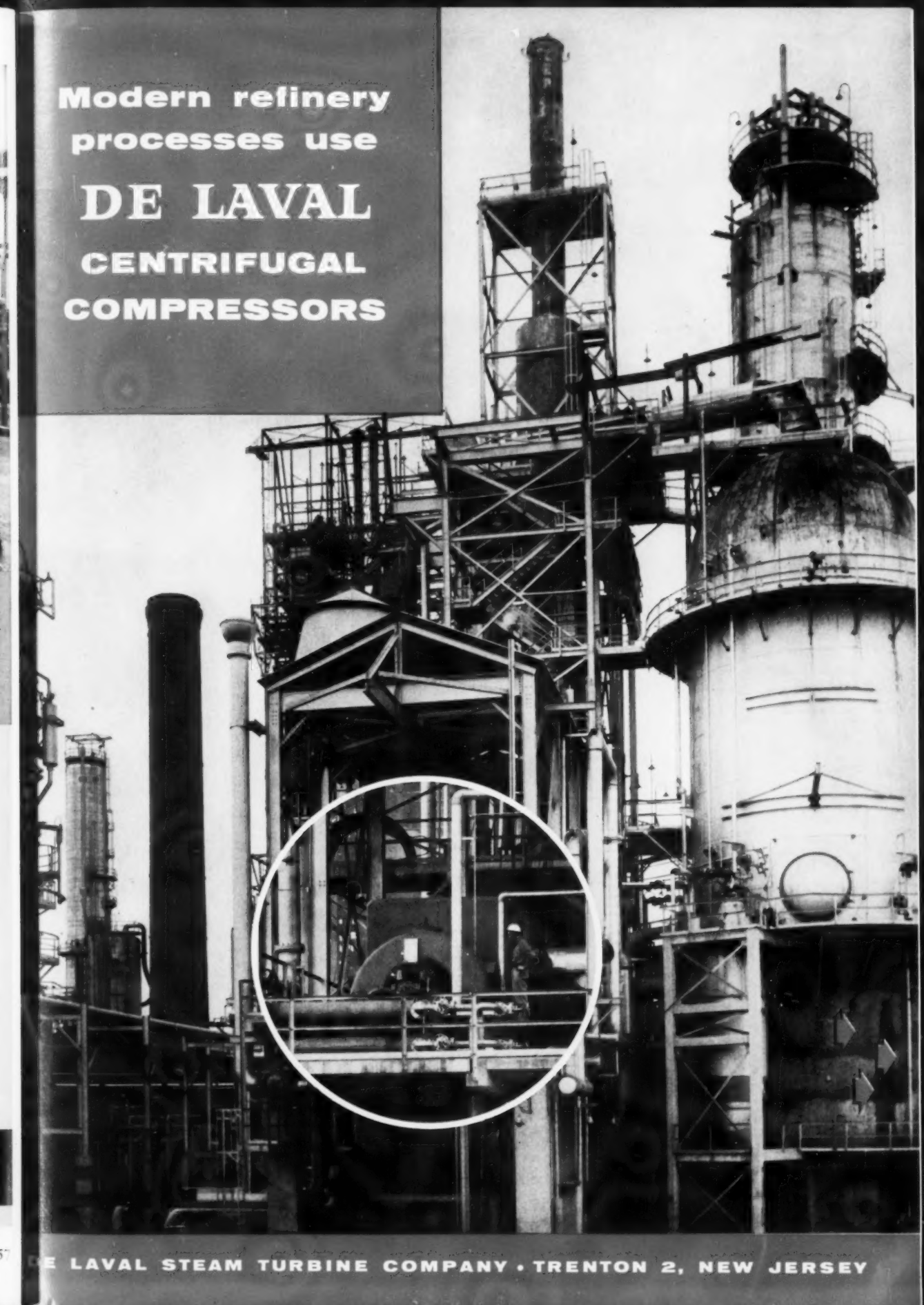
These EC&M 2200-4800 volt Starters are designed for use where hazardous mixtures of air and inflammable gases or vapors are ever-present. NEMA 3R (raintight) enclosure permits mounting indoors, outdoors, or in semi-enclosed location. Load-break oil disconnect switch is self-contained and completely wired into the starter.

Available in two ratings for any power capacity. (*1*) 50,000 KVA (certified) interrupting capacity of EC&M Type ZHS Contactor. (*2*) In VALIMITOR® (volt-ampere-limitor) style... the bus may be of unlimited capacity.

Write **for Bulletin 8131 AM**

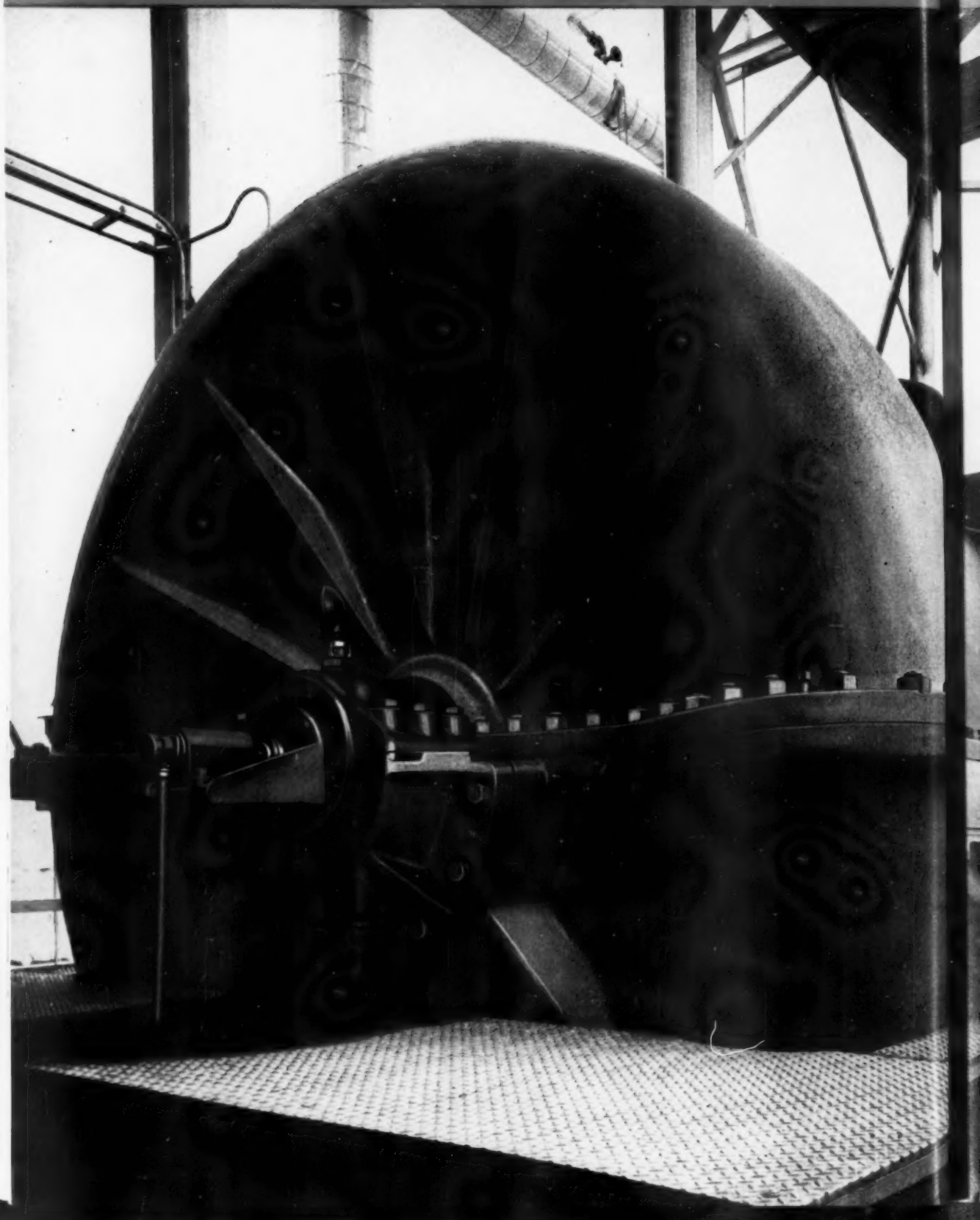
THE ELECTRIC CONTROLLER & MFG. CO.
A DIVISION OF THE SQUARE D COMPANY
CLEVELAND 28 • OHIO

7936


Modern refinery
processes use
DE LAVAL
CENTRIFUGAL
COMPRESSORS
E LAVAL STEAM TURBINE COMPANY • TRENTON 2, NEW JERSEY

DE LAVAL Centrifugal Compress

handles 83,000 cfm of air



shland Oil & Refining Company

This De Laval turbine-driven main air blower handles 83,000 cfm at 47.4 psia in the UOP Fluid Catalytic Cracking Unit at the Ashland Oil & Refining Company plant in Ashland, Kentucky. Built by Procon, Incorporated, the cat cracking unit processes 22,000 barrels per day.

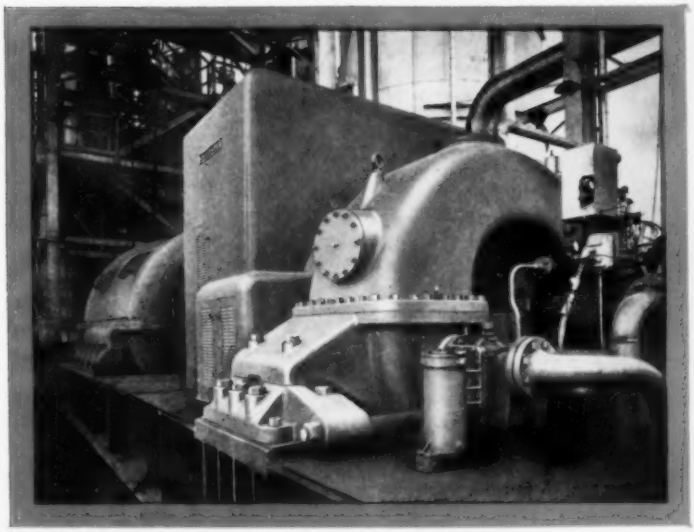
The compressor is driven by a 10,200 hp De Laval extraction turbine designed for 440 psi, operating at 700F with 1½" hg. vacuum. It extracts 150,000 pounds per hour at 155 psig.

As proof of the dependability of De Laval design and manufacture, another De Laval turbine-driven main air blower, which will deliver 110,000 cfm, is on order for a new UOP Fluid Catalytic Cracking Unit. The processing unit is currently being constructed for a leading Midwest refinery.

Available for every refinery process

Whether you need to handle light or heavy gases at high or low pressures in catalytic cracking, reforming, alkylation, coking or any similar service, it pays to look to De Laval. Rugged De Laval centrifugal compressors perform dependably in heavy-duty continuous operation. De Laval has more than 40 years of experience in solving gas compression problems.

Send for De Laval Bulletin 0504.



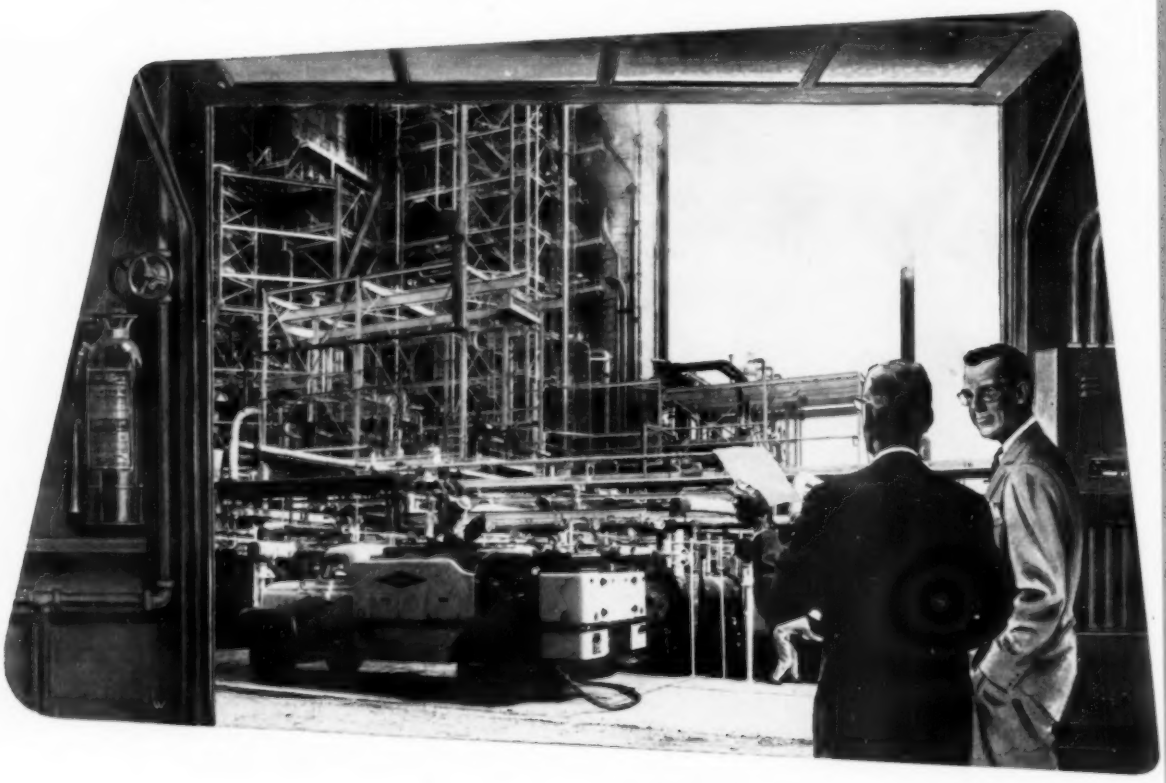
DE LAVAL

Centrifugal Compressors

DE LAVAL STEAM TURBINE COMPANY
900 Nottingham Way, Trenton 2, New Jersey

DL 389

Dowell Service Helped This Plant Profit By Saving $312,700 in Maintenance Costs!



To clean and service the giant catalytic crackers in today's modern refineries is quite a job . . . and very costly. Costly, that is, unless Dowell Service is on the job to help clean the "cats"—chemically. Here's an example of how Dowell chemical cleaning service cut turnaround costs for one refiner by $312,700.

Dowell was called in to provide cat cracker turnaround service which included the cleaning of: two flue gas coolers, two catalyst coolers, four overhead aftercoolers, one light gas oil cooler, one heavy gas oil cooler, two top tray reflux coolers, and two final gas condensers.

Dowell's time: thirteen and one-half hours; Cost: $2300.

It is estimated that this same cat cracker service, if done by mechanical methods, would have cost the refinery: 1) Additional downtime of seven days—$210,000; 2) Additional spare bundle inventory—$100,000; 3) Labor—$5,000.

The refinery enjoyed a $312,700 operating credit from this single cat cracker turnaround—not including expected efficiency increases.

Dowell provides expert service in removing scale and sludge from product, process and steam generating systems. Dowell does the job for you—furnishing all chemical solvents, trained personnel, pumping and control equipment. Furthermore, Dowell has the experience in chemical cleaning to provide assurance of a job well done.

While the example here deals with an oil refinery, Dowell chemical cleaning has recorded similar profit-making savings for other industries. Dowell engineers can show you performance data in almost any field — steel, chemical, power, paper, construction.

For specific information on how Dowell chemical cleaning can help your plant to greater profits, call the Dowell office nearest you. Or write Dowell Incorporated, Tulsa 1, Oklahoma.

have Dowell clean it chemically

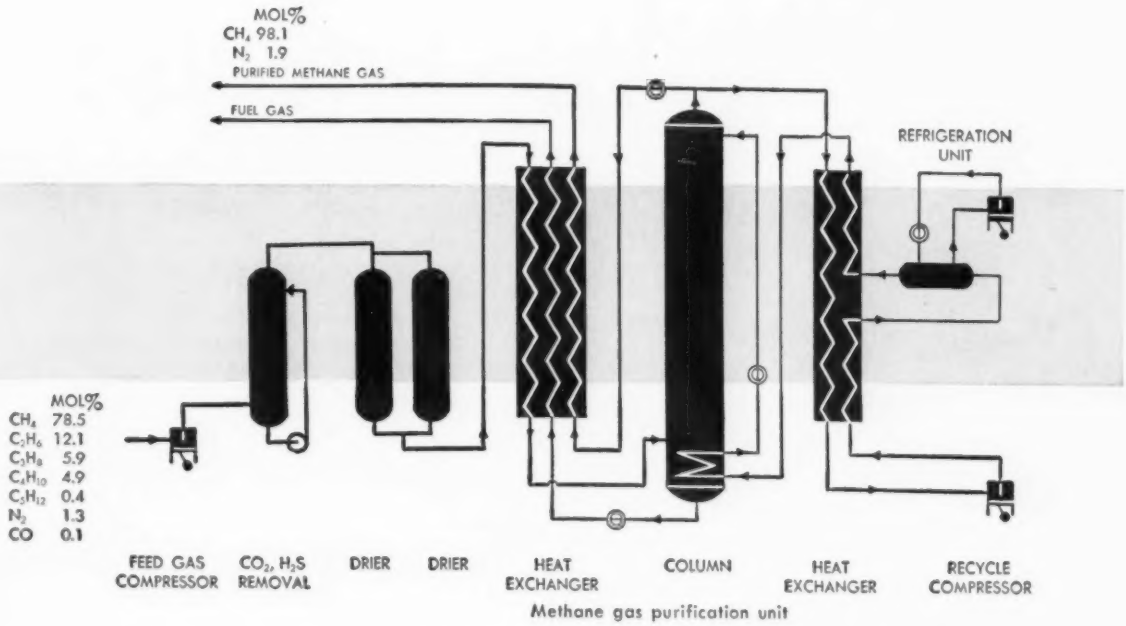
DOWELL

A SUBSIDIARY OF THE DOW CHEMICAL COMPANY

(To obtain more data on advertised products see page 230)

practical approach to

METHANE PURIFICATION



Methane gas purification unit

In the production of chlorinated methane compounds and other chemicals based upon methane, the methane processed must be of ultra high purity. Air Products low-temperature processing plants—accepted as the most economical and practical approach—produce methane containing less than 100 p.p.m. of other hydrocarbons.

Air Products methane purification plants feature many cost-saving and special processing advantages:

- extremely high-purity methane, bone-dry and CO_2-free.
- valuable by-products—LPG, other heavy hydrocarbons, nitrogen.
- automatic control—requiring a minimum of labor.
- low power consumption.
- factory-assembled plants—assuring minimum installation expense.

Many chemical plants are already using Air Products low-temperature equipment. In addition to the production of ultra high-purity methane, Air Products units are being used for the production of oxygen, nitrogen, argon and hydrogen . . . as well as the processing of natural gas, carbon monoxide, deuterium, fluorine and helium.

Here at Air Products, we design, manufacture, erect and operate . . . package, tonnage and custom-built industrial gas separation, liquefaction and purification systems. No matter what your requirements, Air Products will find a way for you to acquire or lease low-temperature equipment on mutually convenient and beneficial terms. Your inquiry is invited. Air Products, Incorporated, P. O. Box 538, Allentown, Pa.

Air Products
...INCORPORATED

(To obtain more data on advertised products see page 230)

Here's why your best steam trap buy is Yarway Impulse

Cross section of Yarway Impulse Steam Trap showing the only moving part, a small stainless steel valve. It actually floats on the condensate load.

more than a million sold!

THERE'S A YARWAY IMPULSE STEAM TRAP FOR EACH OF THESE REQUIREMENTS

As shown opposite, no matter what your need—normal loads, high capacity, low capacity, high pressure, low pressure—Yarway has an *impulse* trap to meet it.

GETS EQUIPMENT HOT FAST—KEEPS IT HOT

Yarway pioneered the application to steam traps of the principle of thermodynamics that makes possible quick heat-up, and high, steady temperatures. Result—peak efficiency from equipment.

ONLY ONE MOVING PART

A little valve is the only moving part. Nothing could be simpler.

LOW MAINTENANCE

Design and material make Yarway Impulse Traps practically trouble-free. A handful of spare parts will service a plant-full of traps.

SMALL SIZE . . . LIGHT WEIGHT

Fit in anywhere. Require no supports or special piping.

GOOD FOR ALL PRESSURES

No change of valve or seat for any pressure up to specified maximum.

NON-FREEZING

Great for outdoor installations. Won't freeze up, because condensate can't accumulate—there's nothing to freeze.

LOW COST

It often costs *less* to install a new Yarway Impulse Trap than to repair a conventional-type trap.

CONVENIENT SUPPLY

Over 270 Industrial Distributors stock and sell Yarway Impulse Steam Traps. One is near you.

NATION-WIDE SERVICE

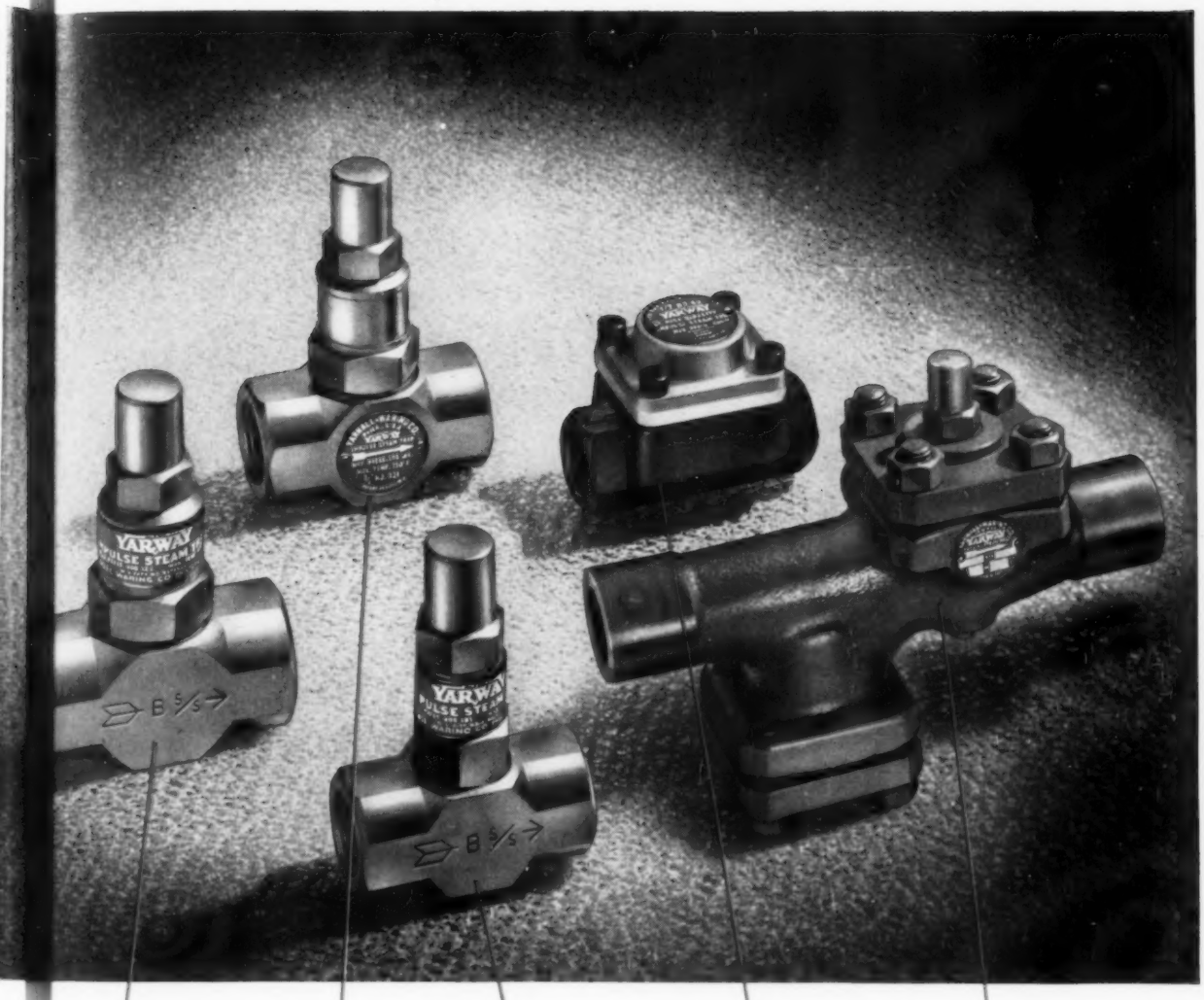
34 trained Yarway field engineers, located in every corner of the country, give you quick, helpful steam trap service.

Want the free booklet "Banish Your Steam Trap Troubles" . . . or the Yarway Trap catalog? Write

YARNALL-WARING COMPANY
153 Mermaid Avenue, Philadelphia 18, Pa.

YARWAY impulse® ...a good

(To obtain more data on advertised products see page 230)



CHOOSE THE RIGHT IMPULSE STEAM TRAP FOR YOUR JOB

NORMAL REQUIREMENTS

Use Yarway Series 60 traps. All pressures to 400 psi and temperatures to 450°F. Six sizes ½" to 2".

HIGHER PRESSURES AND TEMPERATURES

Use Yarway Series 120 traps for pressures to 600 psi and temperatures to 750° F. Six sizes ½" to 2".

LIGHT LOADS

Use Yarway No. 20-A trap where condensate loads are especially light. (Available only in ½" size.)

HEAVY LOADS

Use Yarway Series 40 traps where condensate loads are especially heavy. Five sizes, ½" to 2½".

INTEGRAL STRAINER

For high pressure power plant trapping, also marine use, specify Yarway Integral Strainer Traps. Welding or flanged connections.

way to specify steam traps

(To obtain more data on advertised products see page 230)

Savings in storage, inventory and dollars

Compound your full line of oils with just 2 Oronite®

"additive packages"

detergent package

inhibitor package

The streamlined, money-saving way to blend a full line of motor oils—to cover the range of API service classifications MM-MS-DG-DM-DS—is with just two balanced additives—Oronite's detergent and inhibitor additive "packages." You get the motor oil quality you want but need to buy and inventory only two additives. Further savings are also possible by buying in tank car or CL quantities.

Oronite's "detergent package" contains a mixture of detergent compounds—the "inhibitor package" a mixture of inhibitor compounds. Each "package" is specially balanced and formulated to give optimum response with your base stocks. Formulations can be provided to meet any and all performance levels you require.

Talk over your requirements with Oronite—let us show you how Oronite's "package" program can simplify your storage and inventory problems and enable you to save dollars. Contact the Oronite office nearest you for full information.

ORONITE CHEMICAL COMPANY

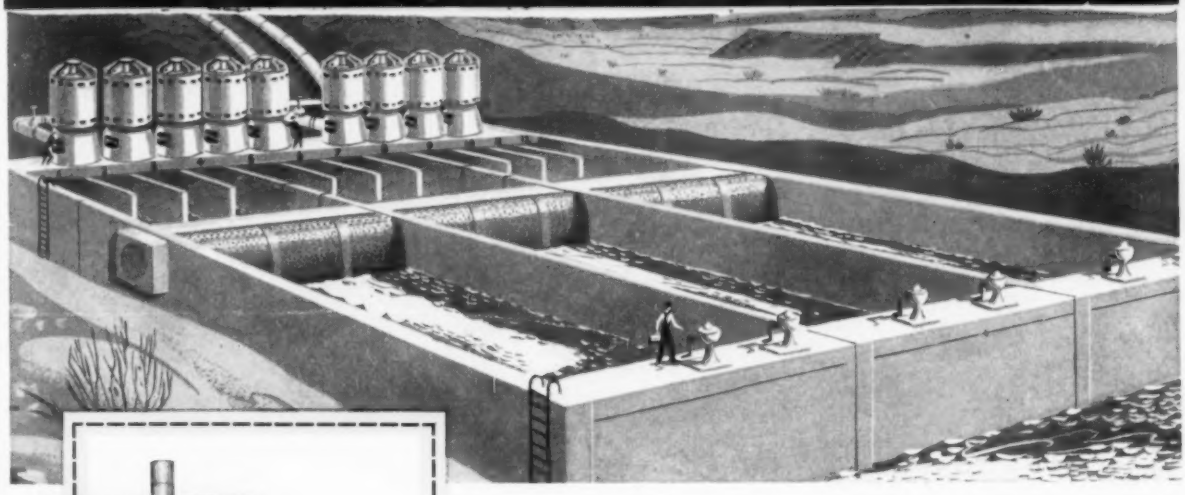
EXECUTIVE OFFICES
200 Bush Street, San Francisco 20, California

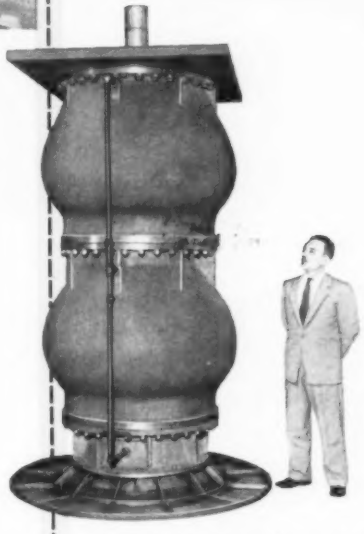
SALES OFFICES
New York, Wilmington, Chicago, Cincinnati, Houston, Los Angeles, San Francisco

EUROPEAN OFFICE
36, Avenue William-Favre, Geneva, Switzerland

4359

Giant new Tidewater refinery selects Byron Jackson pumps for 400 MGD service





TWO STAGE BJ PUMP shown without discharge head and motor.

SPECIAL ENGINEERING REPORT AVAILABLE:

A special engineering report with detailed flow diagrams and color photographs is available. Also, a factual full-color motion picture report can be arranged on request.

Tidewater Oil Company's new Delaware Flying A Refinery is one of the world's largest new refineries. This giant refinery—15 miles south of Wilmington—will use more than 16 million gallons of water per hour. To accomplish this mammoth pumping job, Tidewater and C. F. Braun & Co. (engineers and constructors) selected nine BJ 2000 hp vertical river intake pumps, with provision for installation of three more units.

BJ Pre-Tested the Actual Installation

Because of the special intake system and the untested hydraulic problems involved, it was decided to pre-test the actual pumping conditions. A scale model intake installation—including nine pumps—was constructed in Byron Jackson's Los Angeles hydraulic laboratory. Actual field operations were duplicated in this model. All tests confirmed the correctness of engineering and pumping specifications. In addition, before delivery, Byron Jackson performed exacting hydraulic tests on each of the nine pumps. *These giant pumps tested to an 89.5% efficiency!*

Each BJ pump will be driven by a 2000 hp electric motor at 600 rpm against a total head of 184 feet. Because of the brackish salt water, pump cases, columns and impellers are made of high alloy stainless steel.

BJ
SINCE 1872

Byron Jackson Pumps, Inc.
A Subsidiary of Borg-Warner Corp.
P.O. BOX 2017A, TERMINAL ANNEX • LOS ANGELES 54, CALIFORNIA

(To obtain more data on advertised products see page 230)

HOME IS THE GIANT

Super tankers, 782 feet and less in length will be required to satisfy needs of Delaware's new Tidewater Oil refinery. And in order to berth these oil laden giants, a four-mile, forty-foot channel and turning basin plus deep-draft approaches were created . . . a home, contributed to by American Dredging experience, skill and engineering ability. Congratulations, Tidewater . . . welcome home, giants!

AMERICAN DREDGING COMPANY

Incorporated 1867

dredging ● submarine excavation ● land reclamation ● sand and gravel

12 SOUTH 12TH STREET, PHILADELPHIA 7, PA.

(To obtain more data on advertised products see page 230)

KONTOL
fights corrosion
at TIDEWATER DELAWARE REFINERY

Tidewater Oil Company's all-new Delaware Refinery has spared no detail to assure the very latest and the most efficient in refinery processing equipment.

Significant, then, is their choice of Tretolite's KONTOL CORROSION INHIBITORS for the economical protection of this equipment against a costly variety of corrosive and related problems.

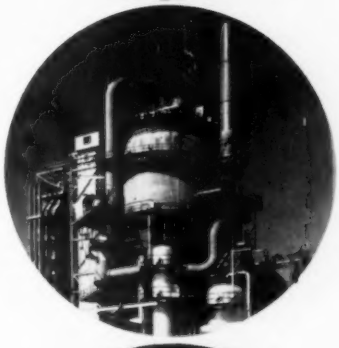
These Kontol Products are on the job at the Refinery in three important places: on the crude unit, the cat cracker and in the coking unit.

In addition to their corrosion inhibiting properties, these same Kontol Products are protecting the equipment against fouling, because of their powerful detergent effect.

CAT CRACKER...

CRUDE UNIT...

COKING UNIT*...



TRETOLITE COMPANY
A DIVISION OF PETROLITE CORPORATION

369 Marshall Ave., St. Louis 19, Mo.
5515 Telegraph Rd., Los Angeles 22, Calif.

Chemicals and Services for the Petroleum Industry

DEMULSIFYING • DESALTING • CORROSION PREVENTION • WATER DE-OILING
PARAFFIN REMOVAL • SCALE PREVENTION

ALL BEING PROTECTED BY

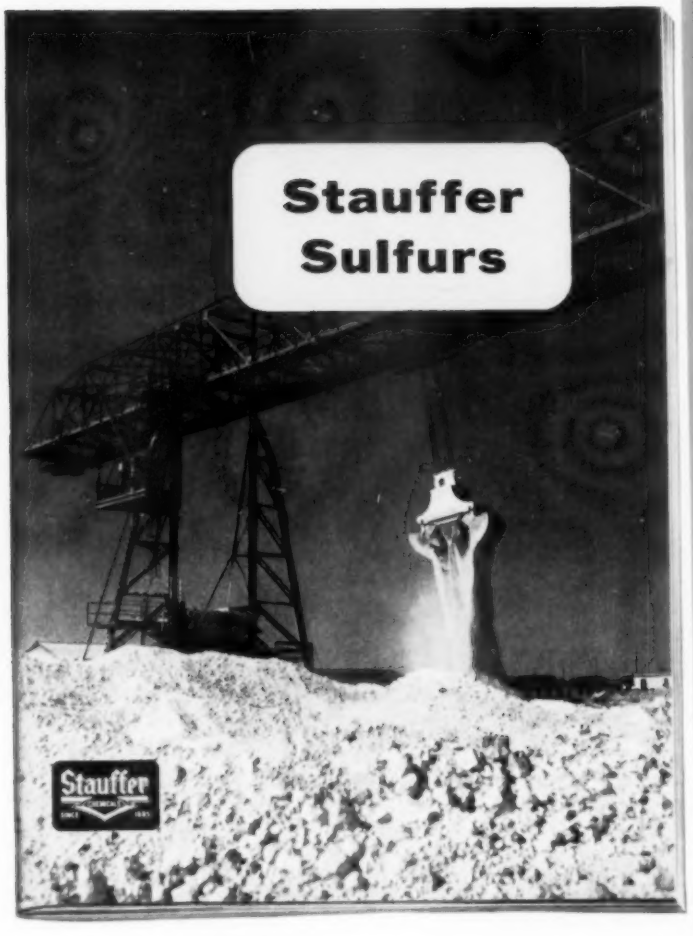
KONTOL
CORROSION INHIBITORS

For more information on these same KONTOL products . . . see
THE MAN IN THE TRETOLITE CAR

TT-57-1

*Photo Courtesy C. F. BRAUN & CO. Engineers and Constructors Alhambra, California

NOW READY...
THE NEWEST BOOK
ON THE OLDEST CHEMICAL



Stauffer Chemical Company — largest user and largest marketer of processed Sulfurs — has prepared a new, authoritative treatise and catalog on Sulfur. The history, preparation and uses, with a detailed description of Stauffer Sulfurs are included in a 52-page brochure with many illustrations and useful tables.

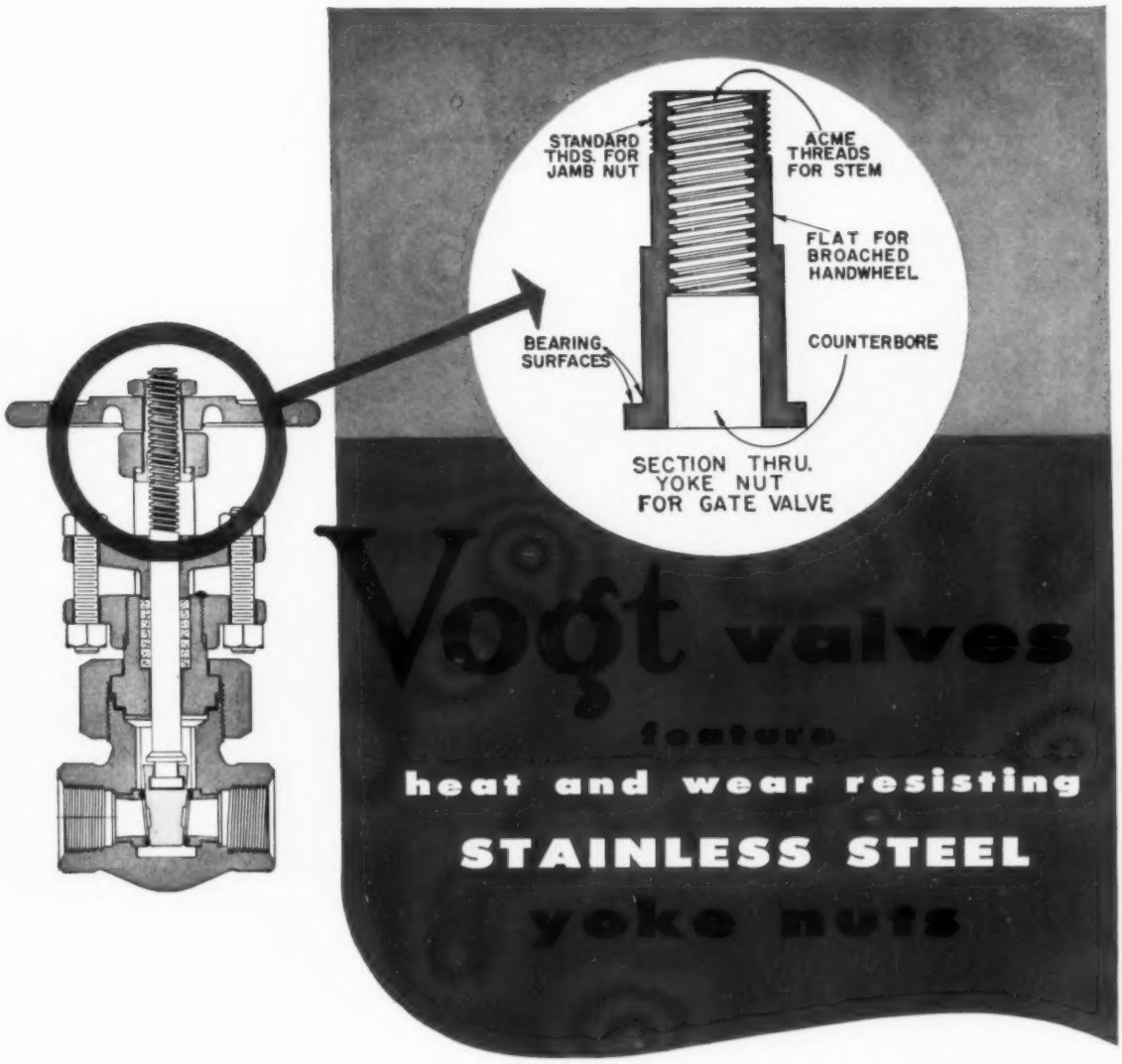
COPIES ON REQUEST; PLEASE WRITE ON YOUR LETTERHEAD.

Stauffer CHEMICALS SINCE 1885

STAUFFER CHEMICAL COMPANY

380 Madison Avenue, New York 17, N. Y.
Prudential Plaza, Chicago 1, Ill.
636 California Street, San Francisco 8, Calif.

(To obtain more data on advertised products see page 230)



Heat and wear-resisting *stainless steel* yoke nuts in Vogt Valves give longer trouble-free service. We have proved this in our own "Torture Chamber," under constant and accelerated testing, as well as in tough service applications. They are made from a special stainless steel alloy having excellent bearing quality, matchless strength, and a melting point of approximately 2700°F.

The rotating gate valve yoke nut design, illustrated, has flats for a tight fit with the square broached hole of the handwheel. Non-rotating yoke nuts, for globe and angle valves, are of the same superior design and quality. Vogt GP Valves are available in a complete range of sizes from 1/4" to 2" and rated 800 pounds at 850°F. and 2000 pounds at 100°F.

Adv. No. 6 in a series describing the features of Vogt GP Valves.

Write For Your FREE COPY of Supplement No. 1 to Catalog F-9. Address Dept. 24A-FPP.

HENRY VOGT MACHINE CO.
P. O. Box 1918—Louisville 1, Ky.

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Philadelphia, St. Louis, Charleston, W. Va., Cincinnati.

Vogt GENERAL PURPOSE GP Vogt FOR BETTER VALVES

DROP FORGED STEEL

VALVES

(To obtain more data on advertised products see page 230)

at Tidewater you'll find . . .

the largest UOP Catalytic

the largest UOP Udex® plant

the largest UOP Unifining®

Polymerization plant ever built

ever built

plant ever built

These three important processes installed on so large a scale at Tidewater, are among many significant developments Universal Oil Products Company has made available to the petroleum refining industry.

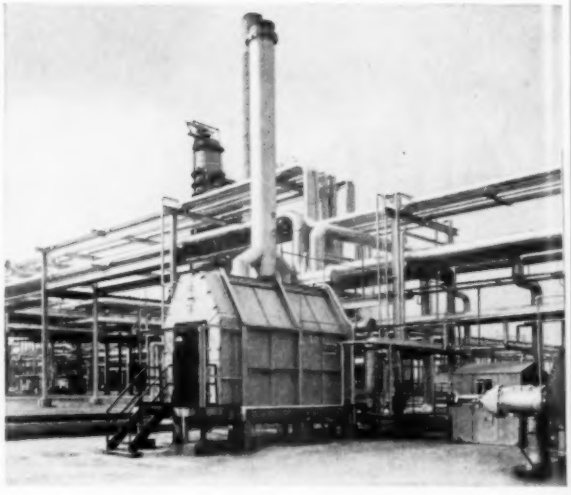
*Trademark

UOP® **UNIVERSAL OIL PRODUCTS COMPANY**
30 Algonquin Road, Des Plaines, Illinois, U. S. A.

More Than Forty Years Of Leadership In Petroleum Refining Technology

(To obtain more data on advertised products see page 230)

GRADIATION® and ECONOTHERM*... Selas Heaters designed and built to meet your processing needs



The Gradiation barrel-type heater (left) superheats steam in two precisely-controlled stages of Tidewater's continuous coking process. The Econotherm heater (above), designed and built to serve low cost requirements where precision heating is not a consideration, maintains asphalt in fluid form for easier handling.

. . . perform critical and non-critical operations at Tidewater Oil Company's ultra-modern Delaware Refinery

Selas is proud to have a part in the development of Tidewater Oil Company's new Delaware plant, the largest refinery ever built at one time. Here, where initial capacity is 130,000 b/d:

- Gradiation heating meets critical processing requirements
- Econotherm heating serves non-critical demands

Each heater is designed and built to perform its specific function.

When the petroleum, petrochemical and chemical industries require preciseness in heating, ability to handle a variety of feed stocks, instant response to controller demand, Zone Control . . . they specify Gradiation. When heating is to be performed below the decomposition point of the material, when low first cost is the important factor . . . they choose Econotherm. Both are Selas heaters; both bring to each process Selas knowledge, skill, experience and service.

Write Dept. 137 for bulletin "Gradiation Heating for Petroleum and Chemical Processing."

* Trade Name

SELAS
CORPORATION OF AMERICA
DRESHER, PENNSYLVANIA

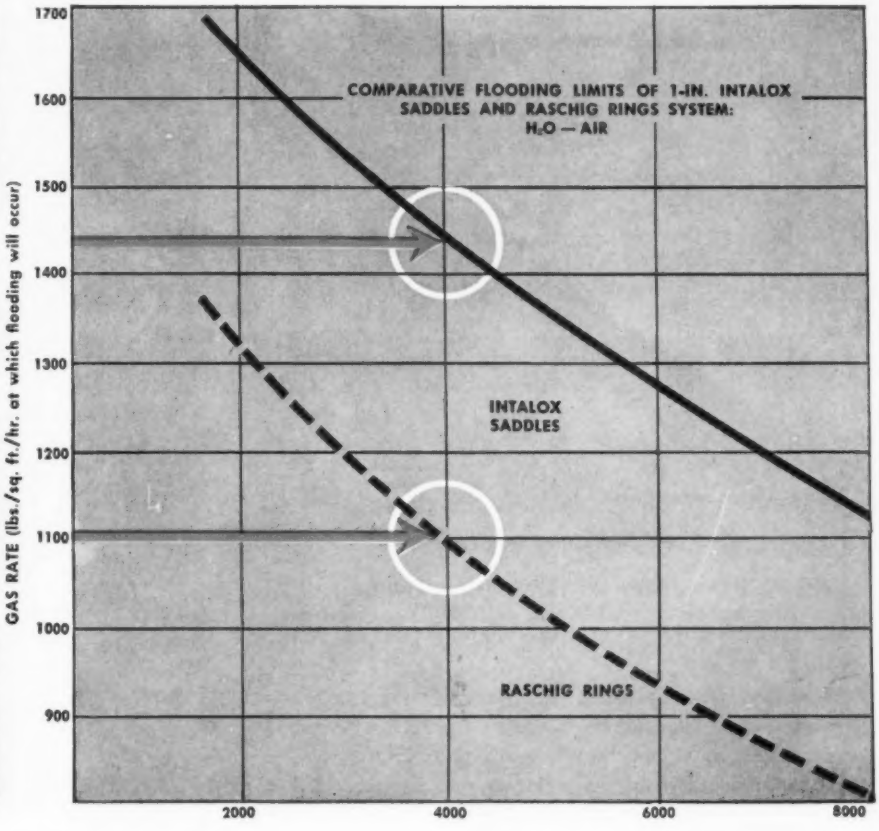
Heat and Fluid Processing Engineers
DEVELOPMENT • DESIGN • CONSTRUCTION

HOW INTALOX SADDLES CAN ADD 30% OR MORE SCRUBBING CAPACITY TO YOUR TOWER

THE higher flooding limits of Intalox saddles offer another convincing factor in any study of relative efficiencies.

For example — if your present tower is packed with Raschig rings, and the tower is now operating to the full limit of its capacity, you can increase its capacity 30% or more by replacing the Raschig rings with Intalox saddles.

Take a look at the chart below showing the comparative flooding limits of 1-in. Raschig rings and 1-in. Intalox saddles at various liquid and gas rates. It was prepared from data based on repeated observations by independent authorities. Suppose a tower packed with Raschig rings is operated at a fixed liquid rate of, say 4000 lbs./sq. ft./hr. Flooding will occur at a gas rate of 1100 lbs./sq. ft./hr. But if the Raschig rings are replaced with Intalox saddles, the gas rate can be increased to almost 1450 lbs./ sq. ft./hr.



Higher flooding limits are only one of the many advantages you obtain with Intalox saddles. The unique, patented "shape" results in a packed bed of greater randomness. There is more surface area per cubic foot, and even more important, virtually all surface area is effective area. There is more free space, and the free space is more uniform.

It will pay you well to learn more about Intalox Saddle packing and how it can help you reduce tower construction and operating costs. Write for Bulletin IS-29.

THE UNITED STATES STONEWARE CO.

Process Equipment Division AKRON 9, OHIO

NEW YORK CHICAGO HOUSTON

we are Proud...

that

YORKMESH DEMISTERS

(MIST ELIMINATORS, ENTRAINMENT SEPARATORS)

are on this Job...

When clean separation between vapor and liquid are important Yorkmesh Demisters are carefully engineered and manufactured to give the performance required.

Details on your operating conditions will enable York engineers to take full responsibility for furnishing the correct Demister. York has more than 10 years of specialized experience in problems such as improving product quality, increasing thruput capacity, reducing maintenance costs and eliminating entrainment losses—by clean separation of vapor from liquid entrainment.

Yorkmesh Demisters give excellent performance in:

Vacuum Towers • Distillation Equipment • Knock-Out Drums • Steam Drums • Gas Absorbers • Scrubbers • Evaporators •

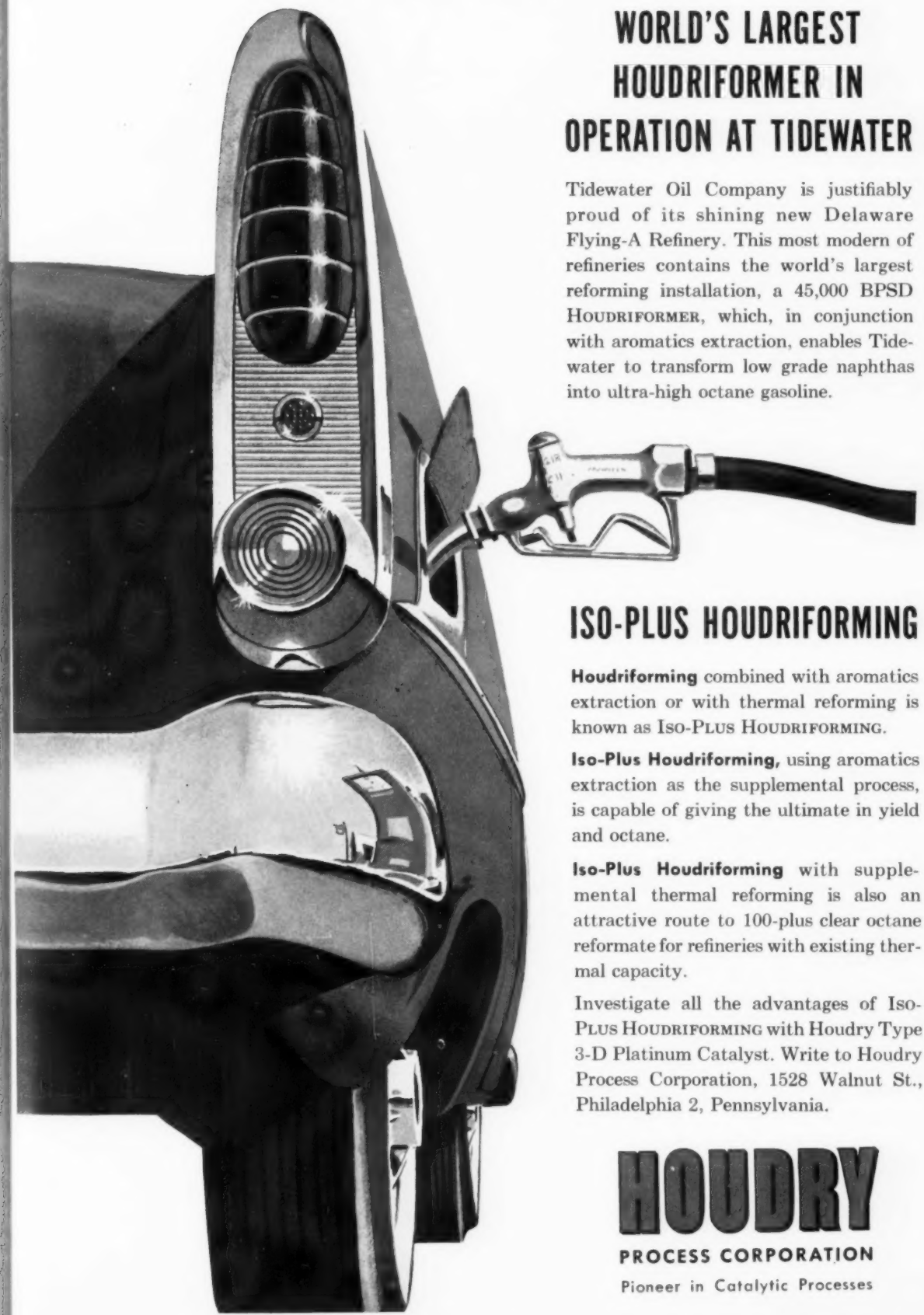
OTTO H. YORK CO., INC.

6 CENTRAL AVENUE • WEST ORANGE, NEW JERSEY

YORK

Specialists in FLUIDS SEPARATION / ENGINEERS and MANUFACTURERS

(To obtain more data on advertised products see page 230)



WORLD'S LARGEST HOUDRIFORMER IN OPERATION AT TIDEWATER

Tidewater Oil Company is justifiably proud of its shining new Delaware Flying-A Refinery. This most modern of refineries contains the world's largest reforming installation, a 45,000 BPSD HOUDRIFORMER, which, in conjunction with aromatics extraction, enables Tidewater to transform low grade naphthas into ultra-high octane gasoline.

ISO-PLUS HOUDRIFORMING

Houdriforming combined with aromatics extraction or with thermal reforming is known as ISO-PLUS HOUDRIFORMING.

Iso-Plus Houdriforming, using aromatics extraction as the supplemental process, is capable of giving the ultimate in yield and octane.

Iso-Plus Houdriforming with supplemental thermal reforming is also an attractive route to 100-plus clear octane reformate for refineries with existing thermal capacity.

Investigate all the advantages of ISO-PLUS HOUDRIFORMING with Houdry Type 3-D Platinum Catalyst. Write to Houdry Process Corporation, 1528 Walnut St., Philadelphia 2, Pennsylvania.

HOUDRY
PROCESS CORPORATION
Pioneer in Catalytic Processes

(To obtain more data on advertised products see page 230)

More than 65,000 hp of I-R Compressors serve

TIDEWATER

DELAWARE REFINERY

Nineteen Ingersoll-Rand compressors, representing more than 65,000 horsepower, will help the Tidewater Oil Company process 130,000 barrels of oil daily at its new Delaware Refinery south of Wilmington. The refinery is the largest ever built at one time. C. F. Braun & Co. were the engineers and constructors of the huge project which includes several processing units that are the largest of their kind.

The I-R compressors – *both centrifugal and reciprocating units* – will handle a variety of gases for the processing units. Each of the nine centrifugals is driven by an Ingersoll-Rand steam turbine. The reciprocating compressors are electric-motor-driven.

Other Ingersoll-Rand equipment used in the refinery includes ejectors and centrifugal pumps. In the general construction of the refinery, I-R tools and portable compressors were used extensively.

This outstanding installation is further evidence of Ingersoll-Rand's ability to design and build air and gas compressors that best meet the most exacting processing requirements of capacity, pressure, dependability and ease of maintenance. An I-R engineer will be glad to give you complete information on a compressor best suited to your needs.

Ingersoll-Rand

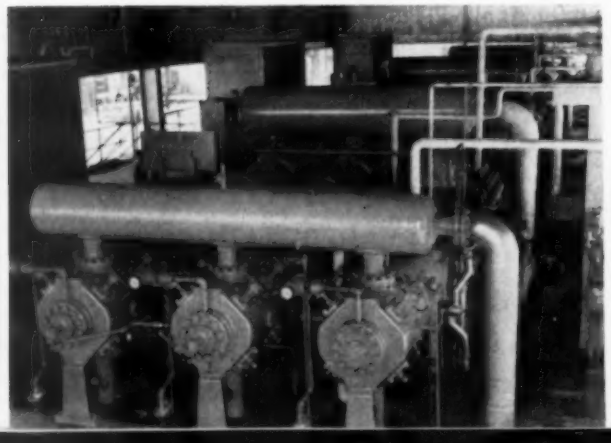
12-638

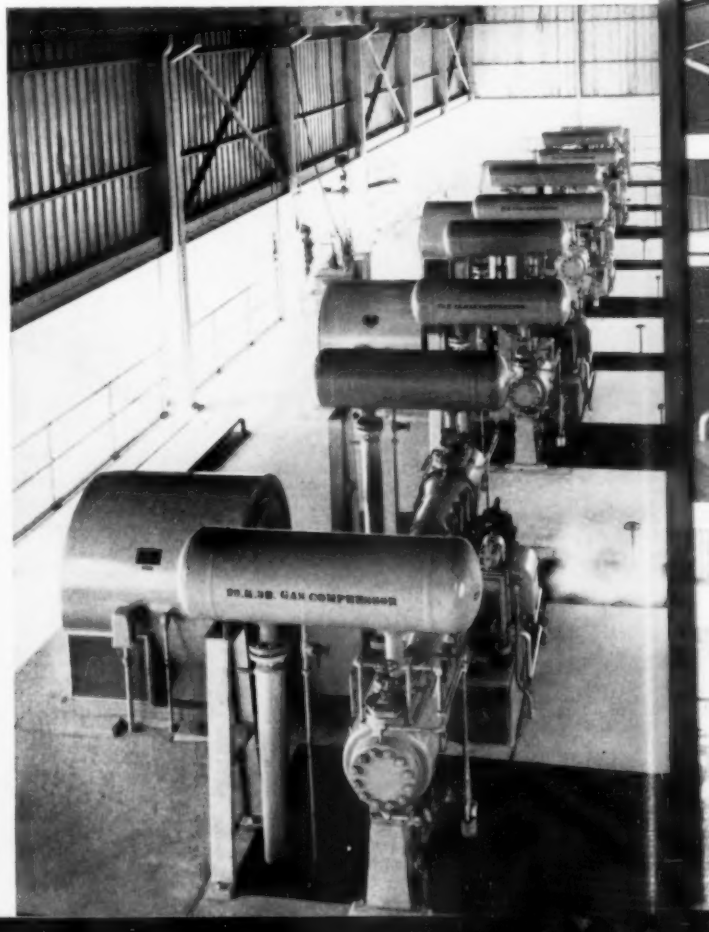
11 Broadway, New York 4, N. Y.

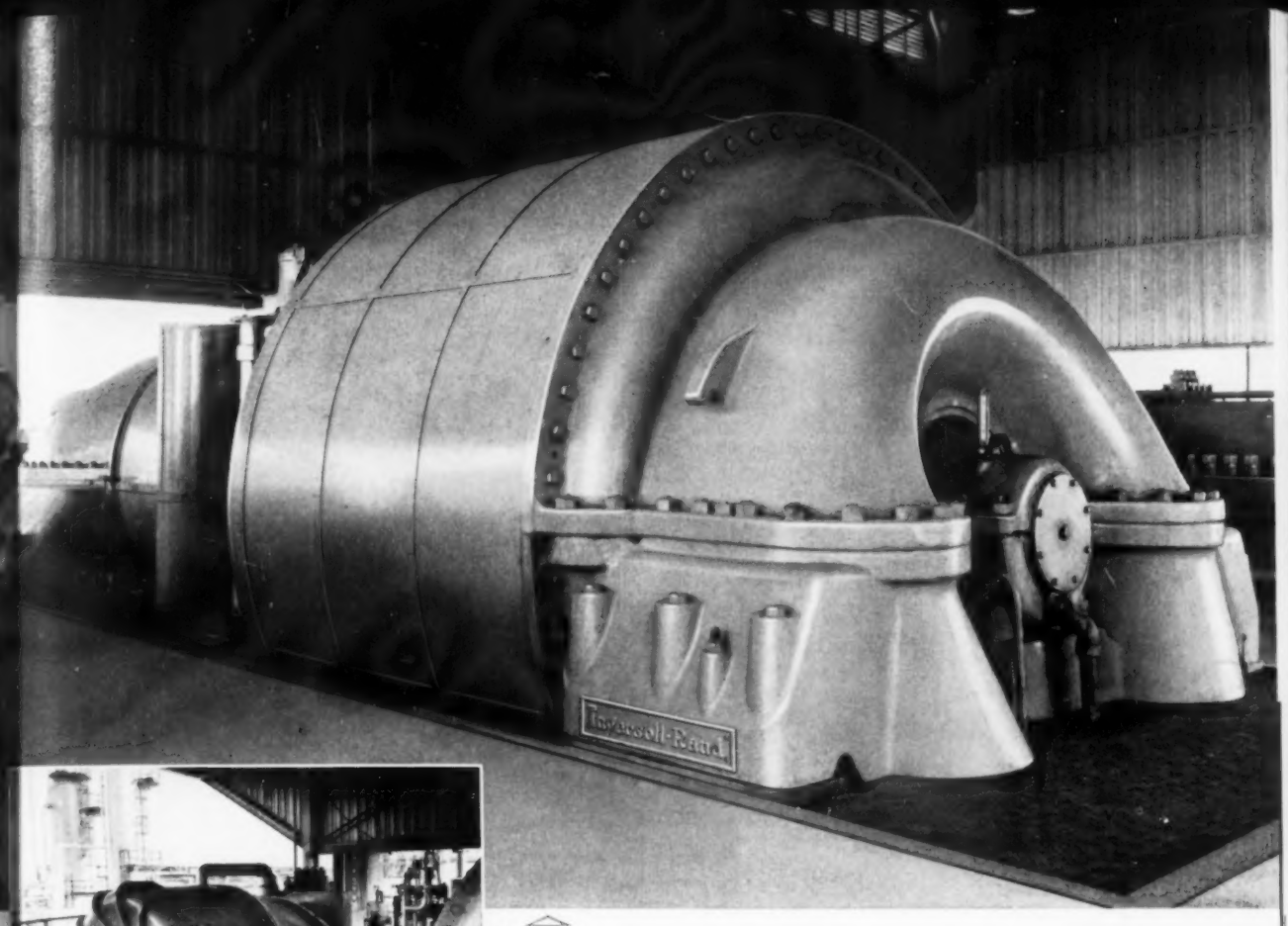
CENTRIFUGAL PUMPS • COMPRESSORS • TURBO-BLOWERS • VACUUM EQUIPMENT • AIR AND ELECTRIC TOOLS • DIESEL AND GAS ENGINES

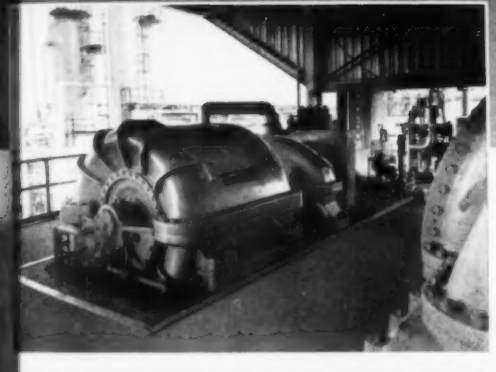
DESULPHURIZATION UNIT
For circulating hydrogen gas in the desulphurization unit six Ingersoll-Rand HHE compressors are used. Two 800-hp units, not shown, have non-lubricated cylinders. An Ingersoll-Rand ES Compressor serves as a recovery compressor.

HYDROGEN PLANT–Three Ingersoll-Rand 3000-hp HHE reciprocating compressors serve the hydrogen plant which produces 30,000,000 cubic feet per day of make-up hydrogen used in the reformer and desulphurization units. Each compressor has a capacity of 2,280 cfm.

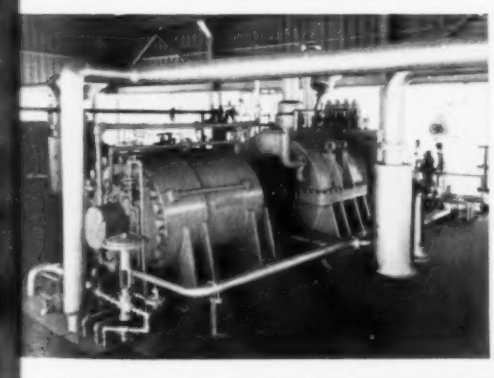






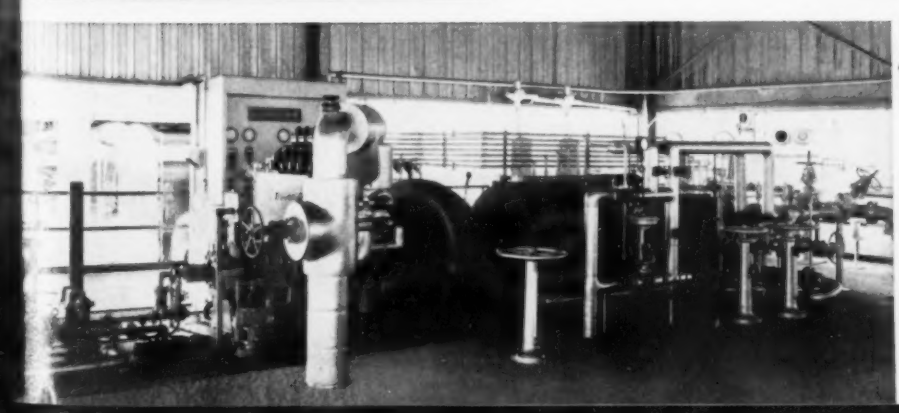


ORTHOFLOW CRACKER, the largest cat cracker ever built, is served by this huge I-R Turbo-Blower — a 161,500 cfm unit that discharges at 30 psia. It is the largest cat-cracking air blower in the world and is driven by an I-R 11,250-hp steam turbine. The 3000-hp I-R centrifugal shown at left serves as the carrier or fluidizing compressor on the cracking unit.



HOUDRIFORMER
Two I-R steam-turbine-driven barrel-type centrifugal compressors recycle hydrogen gas. Each unit is rated 5050 cfm at 675 psia discharge pressure.

GAS PLANT uses two I-R centrifugals to transfer hydrocarbon gases from the cracker. Operating in parallel, each is rated 15,500 cfm, 200 psia discharge and each is driven by an I-R steam turbine.



FLUID COKER, also the world's largest, is served by three Ingersoll-Rand Centrifugals — each driven by an I-R steam turbine. The main air blower, rated at 109,200 cfm at 29 psia is equipped with I-R adjustable inlet guide vanes to permit full-pressure operation down to approximately 30% rated capacity. At the left is one of the two tandem I-R centrifugals that serve as transfer gas compressors. Each is rated 16,100 cfm at 230 psia.

STARTING #15
FOR NATIONAL LEAD COMPANY!
Here at CHEMICO, we believe that the best evidence of a satisfied customer is a repeat order. That's one reason why we are so pleased to report that National Lead Company has signed its fifteenth contract for facilities for the production of sulfuric acid. We are proud to have played such an important part in this client's impressive expansion during the last quarter of a century.
The same service and engineering know-how which led to fifteen contracts from National Lead Company is available to all CHEMICO clients. Whether you are considering the expansion of present facilities, or the building of new facilities, CHEMICO's design, engineering and construction services assure you of economy and efficiency at every stage of your project.
If you are interested in producing Acetylene, Urea, Methanol, Ammonia, Sulfuric Acid or almost any other industrial chemical, CHEMICO's continuing experience in these fields can save you time and money. Check with CHEMICO before you decide.
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CHEMICAL CONSTRUCTION CORPORATION
A SUBSIDIARY OF ELECTRIC BOND AND SHARE COMPANY
525 West 43rd Street, New York 36, N. Y. • Cable Address: CHEMICONST, New York
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REPRESENTATIVES in JOHANNESBURG • PARIS • TOKYO

(To obtain more data on advertised products see page 230)

JACK B. RINCKHOFF (right), Chief Engineer, Sulphuric Acid & Phosphates Dept., Chemical Construction Corp., N. Y. City. Left, Michael De Piano, New York Cooper Alloy Representative.

RINCKHOFF OF CHEMICAL CONSTRUCTION

answers 3 questions on Cooper Alloy Valves

Q. Mr. Rinckhoff, in specifying equipment for the H_2SO_4 plants that Chemico constructs around the world, what Cooper Alloy valve models do you buy most of?

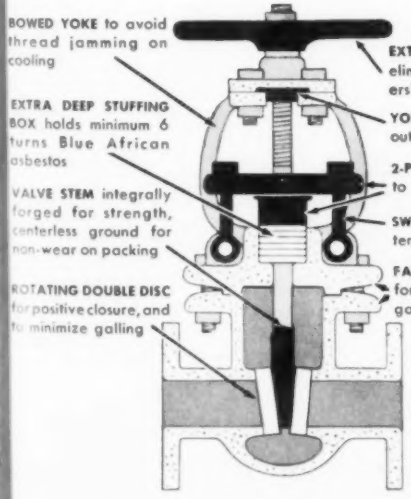
A. Over 80%, I'd say, are OS&Y type gate valves, in sizes 1"to 8"

Q. What's your most important reason for buying Cooper Alloy valves?

A. Availability. Your chain of distributors across the country and in remote parts of the world is of great importance to us. In foreign construction we have often specified Cooper Alloy because of this all-important availability.

Q. What about design and quality?

A. Vital. Valve design determines performance, and our specifications are rigid. As a construction company, we can't afford to jeopardize our reputation by installing questionable equipment. Cooper Alloy valves have passed our tough specs, and have my approval for all severe construction applications.


BOWED YOKE to avoid thread jamming on cooling
EXTRA DEEP STUFFING BOX holds minimum 6 turns Blue African asbestos
VALVE STEM integrally forged for strength, centerless ground for non-wear on packing
ROTATING DOUBLE DISC for positive closure, and to minimize galling
EXTRA LARGE HANDWHEEL to eliminate need for "persuaders"
YOKE NUT REPLACEABLE without valve disassembly
2-PC. GLAND CONSTRUCTION to prevent scoring of stem
SWINGING EYEBOLTS for maintenance convenience
FAIRED BODY-BONNET FLANGES for equal stress and uniform gasket loading

A VALVE DESIGNED FOR STAINLESS!

The Cooper Alloy valve is not an adaptation of earlier brass and iron patterns. Cooper Alloy, with over 35 years of experience in handling stainless steel, created a valve *designed to be cast in stainless!* **Check the Special Design Features shown at left.**

As the little CA man below is saying: "*You can tell a Cooper Alloy Valve as far as you can see it!*" Write today for *your* copy of our folder "Design Factors In Stainless Steel Valves." The Cooper Alloy distributor near you will be glad to show you the complete line of Cooper Alloy valves *and fittings*, and their advantages. He can serve you promptly from local stocks.

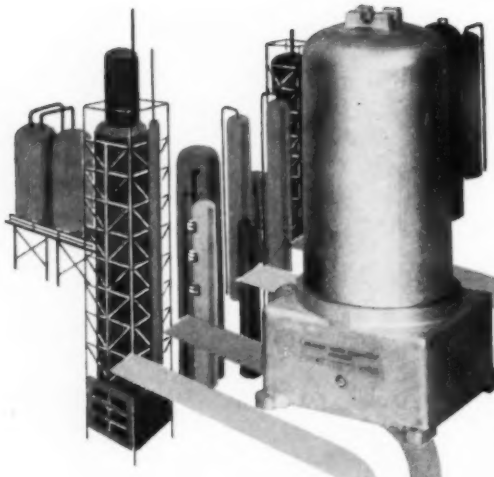
COOPER ALLOY

Corporation • Hillside, New Jersey

VALVE & FITTING DIVISION

THIRTY-FIVE YEARS OF STAINLESS STEEL PIONEERING

(To obtain more data on advertised products see page 230)

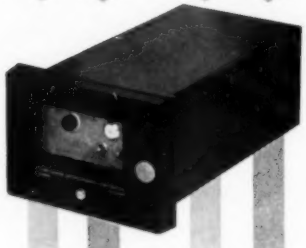


REMOTE OPERATION

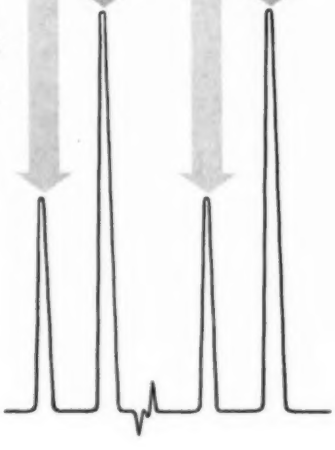
Mounted at the sample point–operated from the control house–CEC's Type 26-202 Process Chromatograph gives you a simple, trouble-free system in two units. The Analyzer unit meets specifications for installation in Class I, Group D. Division 1 hazardous locations. From its remote location, the Control unit provides timing and control for all programming requirements.

RELIABILITY WHERE IT COUNTS

...at the process stream



CEC's PROCESS CHROMATOGRAPH



OUTSTANDING RELIABILITY

There are no vacuum tubes in the CEC Process Chromatograph. Its one power supply is completely transistorized. Accuracy of detector elements and calibrations can be checked at the Control unit.

SUPERIOR REPRODUCIBILITY

Precise regulation gives you these specific advantages: Sample volumes are reproducible to better than $\pm 1/2\%$. Sample and column temperatures are held within $\pm 1°F$. Variations in the carrier gas flow-rate cannot exceed $\pm 0.1\%$, and voltage regulation for the thermal conductivity cell is better than 0.05%.

BEFORE YOU BUY any gas chromatograph, get acquainted with CEC's Process Chromatograph. For complete data and cost of this fast, inexpensive analyzer, contact your nearby CEC field office, or write for Bulletin CEC 1836-X10.

Consolidated Electrodynamics

CEC

300 North Sierra Madre Villa, Pasadena, California

NATIONWIDE COMPANY-OWNED SALES & SERVICE OFFICES

(To obtain more data on advertised products see page 230)

Always Stronger

Than They Need Be!

MIDWEST

WELDING FITTINGS

Below are photographs of two of the many tests that have been made of Midwest Welding Fittings. The results are *always* the same . . . the seamless pipe to which the fittings are welded invariably bursts. There is *never* any sign of fitting failure or weakness.

There's good reason for this. We make elbows and tees of inherently stronger metal . . . the Midwest exclusive method of manufacture enables us to maintain greater minimum wall thickness, and to reinforce the fittings at points of greatest stress. For the many other advantages of Midwest Fittings, ask your Midwest distributor or write us for Catalog 54.

MIDWEST PIPING COMPANY, INC.

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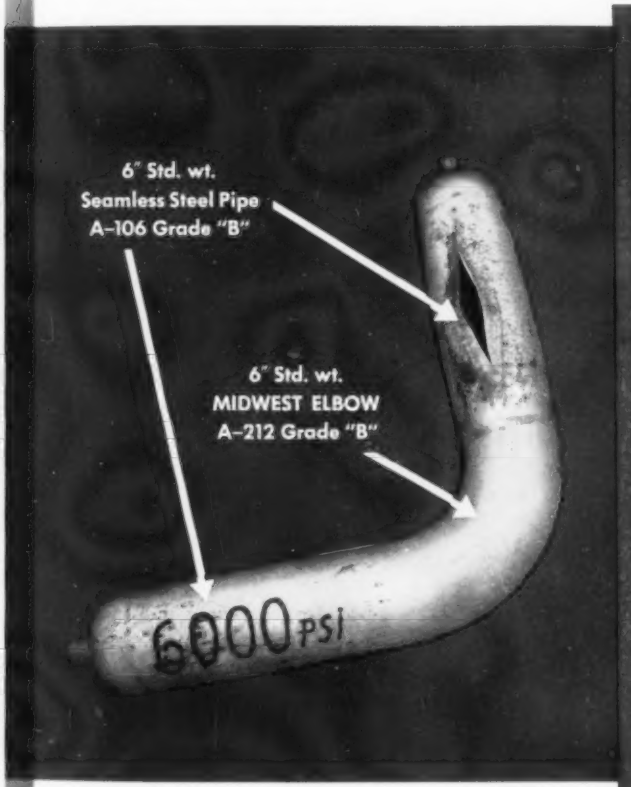
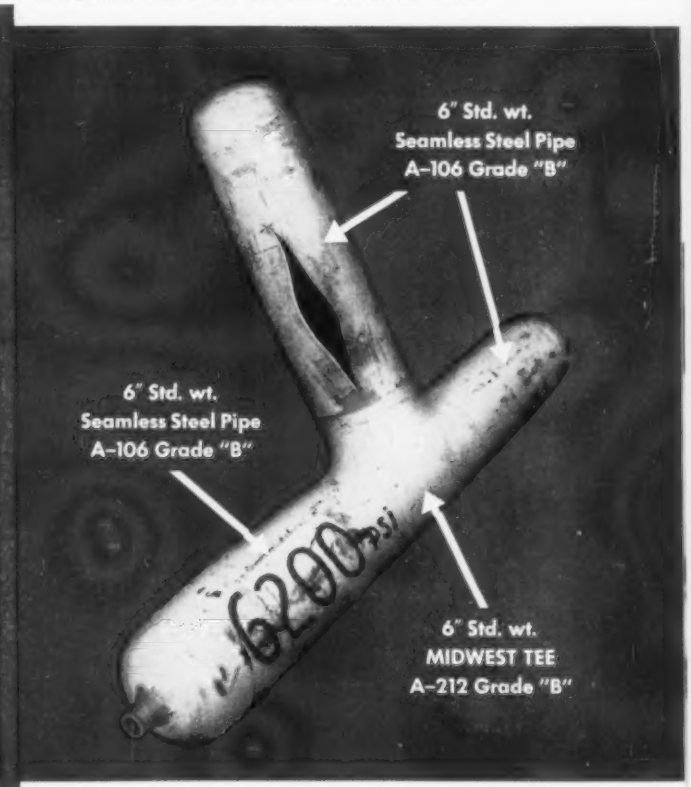


Typical bursting test of stock Midwest Welding Elbow. As is always the case, failure occurred in the seamless pipe while the elbow was undamaged. Bursting pressure was 6000 psi . . . considerably above the required code minimum for seamless pipe. (Minimum allowable bursting pressure for 6" standard weight A-106 Grade B seamless steel pipe is 4438 psi.)



Bursting test of Midwest Welding Tee taken at random from stock. As always, the failure occurred in the seamless pipe and not in the fitting. The non-shock internal bursting pressure of 6200 psi is well above the code minimum for seamless pipe. (Minimum allowable bursting pressure for 6" standard weight A-106 Grade B seamless steel pipe is 4438 psi.)

7761

MIDWEST WELDING FITTINGS IMPROVE PIPING DESIGN AND REDUCE COSTS

Another Milestone...

TIDEWATER'S FLYING "A" REFINERY..Pr

..Pressure and Liquid Level Controlled by FISHER

J. W. Fisher, President
Fisher Governor Company

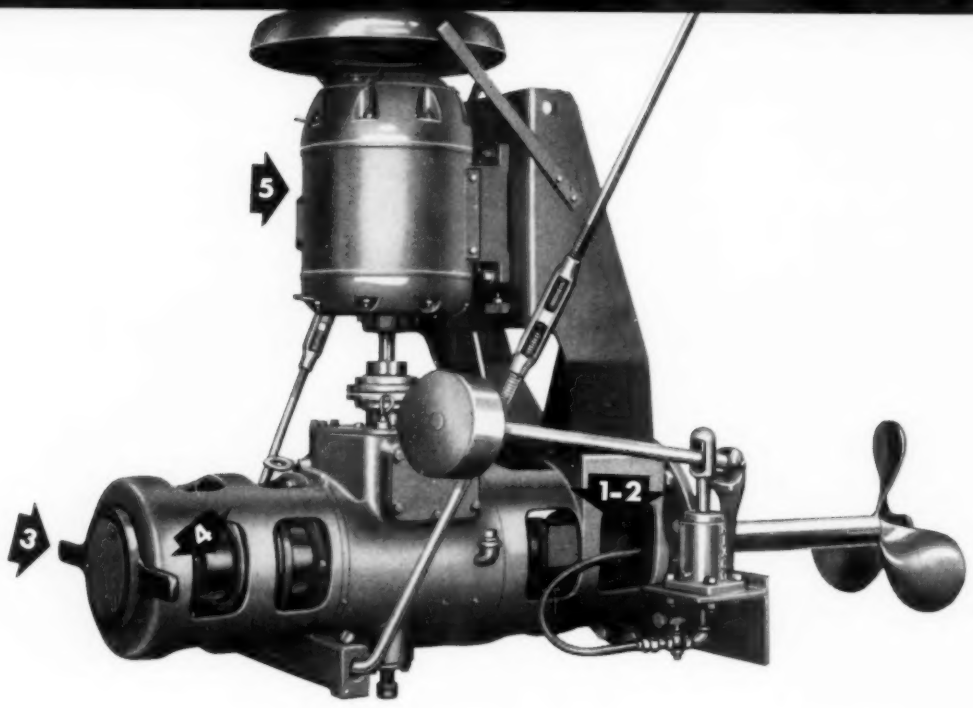
"Today the world realizes the immensity of the undertaking which culminated in the largest refinery ever built at one time—anywhere.

"We, at Fisher, congratulate Tidewater for having brought to the industry the latest word in modern refinery technology.

"All of us are genuinely proud that our products and services have been chosen to perform the important control functions in the Flying A Refinery."

J. W. Fisher

FISHER GOVERNOR COMPANY
MARSHALLTOWN, IOWA / WOODSTOCK, ONT.



Can you answer these **5 cost-cutting questions** *about big-tank mixers?*

If you can, you know how to get most efficient mixing for your company

1 How can I get mixer shaft seals that meet any operating conditions? It's easy—just standardize on LIGHTNIN Mixers for your big tanks. Get your choice of *four* standard stuffing boxes, or a wide choice of rotary mechanical seals. With LIGHTNINS, you're sure of getting the *right* shaft seal for years of trouble-free mixing or blending.

2 What's the advantage of LIGHTNIN cartridge-type rotary mechanical shaft seal? No stuffing box to repack or maintain. You can replace the LIGHTNIN Seal in minutes, if it ever wears out. No need to drain the tank or dismantle the mixer; no need for special skill—you're back in operation fast! Many users of the LIGHTNIN Seal are saving thousands of dollars per year with this exclusive feature.

3 What's the quickest, simplest way to shut off tank contents before repacking, or changing a seal? The LIGHTNIN way! Easy-to-get-at handles are out in the open, always accessible. A few turns provide quick, positive shutoff of tank contents from mixer. Only LIGHTNIN gives you this time-saving advantage.

4 What mixer gives me most protection of the drive gears? LIGHTNIN again! The mixer shaft, in LIGHTNIN gear drive models, passes through a hollow drive quill. Shaft and quill are supported by separate sets of bearings, connected only by a flexible coupling. This coupling cushions shaft flexures and strains—keeps excessive shock loads from ever reaching the gearing. This construction adds years of safe operating life.

5 What's a good way to keep motor safe from dirt, dust, excessive moisture? Put the motor on top! This design, exclusive with LIGHTNIN, not only protects the motor; it centers weight closer to tank wall. You can choose standard foot-mounted motors, as shown, or round-frame NEMA Type P flange-mounted motors in all enclosures and all current characteristics. All motors are fully guaranteed.

These are just five of the engineering reasons why you get better, lower-cost mixing with LIGHTNIN Mixers. Your nearby LIGHTNIN representative can show you more. For quick, competent help on fluid mixing, look him up in Refinery Catalog. Or write us direct.

CUT MAINTENANCE COST with this quickly replaceable cartridge-type rotary seal, available on all LIGHTNIN Side Entering Mixers. Seal takes the place of a stuffing box; ends repacking for good; runs for years without adjustment; slides off for fast, easy replacement.

"Lightnin® Mixers"

MIXCO fluid mixing specialists

☐ ***Quick!*** **Send us the cost-cutting facts on LIGHTNIN Rotary Mechanical Seals—Bulletin B-111. We'd also like catalog information on these LIGHTNIN Mixers:**

- ☐ B-102—Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP
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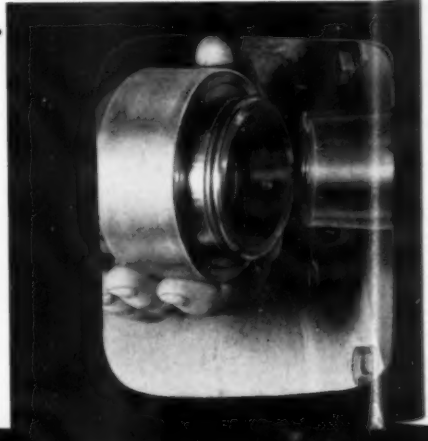
- ☐ B-104—Side entering: 1 to 25 HP
- ☐ B-108—Portable: ⅛ to 3 HP
- ☐ B-112 Laboratory and small-batch production types
- ☐ B-110—Condensed catalog showing all types
- ☐ B-107—Data sheet for figuring mixer requirements

Check, clip, and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 131-g, Mt. Read Blvd., Rochester 11, N. Y.

In Canada: Greey Mixing Equipment, Ltd., Toronto 10, Ont.



Petroleum Processing
July, 1957

The complete technical story of the world's most modern refinery...

TIDEWATER

32 detail-packed feature articles in 72 pages...for contents see page 101

By WILLIAM F. BLAND
Editor

THE Refinery of the Future" is how Tidewater Oil Co. describes its new 130,000 b/d Delaware Refinery—located on a 5,200-acre site along the Delaware River 15 miles south of Wilmington, Del.

The new plant—under construction since 1955—was officially dedicated May 23, and is now almost completely onstream.

It is the largest new refinery ever built as a single project—and it doesn't take much imagination to agree that "Refinery of the Future" is probably the most fitting and succinct description for it.

- Six of the refinery's 11 major processing units are the largest yet built; 130,000 b/d crude unit, 102,000 b/d Fluid Catalytic Cracker, 42,000 b/d Fluid Coker, 45,200 b/d reformer, 45,000 b/d extraction unit, and 88,000 b/d desulfurizer capacity.
- It is designed to charge low-gravity, high-sulfur crude, and at the same time maximize yields of distillate fuels. It is entirely a fuels refinery—no lubes or asphalt.
- It is capable of making its entire gasoline output of better than 100 octane quality—and that at a rate of 65,000 b/d.
- All distillate fuel products are blended automatically in continuous stream blenders.
- Each of the major processing units is equipped with an automatic data logger—which not only records pertinent operating data regularly but also monitors the unit continuously and sounds an alarm whenever any control point reading goes beyond predetermined limits.
- A program is now being developed to take selected data from each unit, feed it into an IBM 650 computer, and come out with overall refinery operating figures and yields—almost in a matter of minutes.
- All crude and product tankage is automatically gaged remotely, and the readings then fed into a computer which gives the liquid content of any tank in barrels—corrected for temperature, gravity, and tank irregularities.

1953 was "Year of Decision"

Tidewater's new Delaware refinery replaces its old 85,000-b/d plant at Bayonne, N. J.—closed two years ago. But why did Tidewater give up an operating refinery which included some modern processing units, and a location where they had been in business since the 1880's?

In May, 1953, the company's management began taking a really close look at the economics of its entire East Coast operations. Studies made at that time indicated that the area held tremendous potential for expansion.

The company was convinced, however, that the Bayonne refinery was not the place to expand. In fact, Bayonne was not even a paying proposition at that time, and the prospects for making it one seemed remote.

There were four main reasons for Bayonne's economic plight in 1953:

1—High taxes. Tidewater was paying $1.9 million a

"in design . . . management adopted

year in local taxes in Bayonne—which amounted to about 15-20% of the total local tax collection.

2—Lack of room. The total plant area at Bayonne included only about 230 acres—and didn't allow space for expansion or modernization.

3—Obsolete equipment. The plant had done considerable modernization during the past decade—but a good deal of it was aimed at lubes, not fuels. New propane deasphalting and furfural extraction units had been installed in 1948, and MEK dewaxing expanded. On the fuels side, the plant had a 12-case Houdry fixed-bed catalytic cracker with a total charge capacity of 16,000 b/d, and a 10,000 b/d TCC bucket-elevator unit. The Houdry cases were installed in 1941, the TCC unit in 1945.

There was no catalytic reforming, no alkylation. The only "modern" unit for producing gasoline quality was a 3,300 b/d catalytic polymerization unit—and that couldn't run at capacity at all times because of a lack of feed stocks. In addition, the refinery couldn't tolerate high-sulfur crudes. It had to run on sweet crudes to keep the equipment from being chewed up—and even then was hard-pressed to get close to 50% gasoline yield. On quality, gasoline was already being leaded to the limit.

4—Too many People. Although running only 85,000 b/d, the plant had a payroll of 2200. It wasn't necessarily "overstaffed"; that many people were needed to keep it going because of the multiplicity of small units and the high maintenance requirements of obsolete equipment.

With these points in mind, and already pretty much convinced that Bayonne was a hopeless situation, Tidewater in May, 1953, hired C. F. Braun & Co. to make a study of building a new Gulf Coast refinery. That plant was projected on the basis of running entirely domestic crudes, mostly from Louisiana and Texas. Crude availability, however, would have limited capacity to about 58,000 b/d—not enough to meet what Tidewater thought its future needs would be.

About the same time some of the Tidewater affiliates began to develop substantial crude reserves in the Middle East—and it became apparent that Tidewater's future operations would have to be based on running at least some imported crude. The Gulf Coast project was dropped.

Next step was a second study by C. F. Braun & Co. later in 1953 on the total economics of a new East Coast refinery versus remodeling Bayonne. At the same time Tidewater assigned some of its own people to make an entirely independent study of the possibilities of staying at Bayonne and remodeling. Both the Braun and Tidewater projects were based on remodeling to upgrade product quality and run some sour Middle East crude.

The consensus of both studies: Get out of Bayonne and build a new plant somewhere on the East Coast. The new Tidewater Delaware Refinery is the result.

A new philosophy in design

Major engineering and construction contractor on the refinery was C. F. Braun & Co., Alhambra, Calif. Engineering and design were handled by engineers of Tidewater Oil Co. and Braun, working with engineers of the process licensors. Braun handled construction.

In designing the new refinery, Tidewater's management adopted a somewhat novel philosophy. The company management handed down instructions that this was one plant that was not to be designed in any way simply because it had been done that way in the past. They gave clear orders to the designers to take a close look at everything—and to come up with the best possible design, uninhibited by previous practices and conventions.

To achieve this aim, a "New Refinery Advisory Committee" was set up by Tidewater in March 1954, and was sent to Alhambra to work with Braun. This committee was charged with the responsibility of seeing that the "best possible design" philosophy prevailed. It was composed of operators, engineers, maintenance men, and research and development representatives from Tidewater operations at both Bayonne, N. J., and Avon, Calif. Initially, there were six men on it—but the group grew to 13 before its job was done.

This group and Braun's engineers discussed and explored every phase of the refinery design. The whole approach was "don't accept anything at face value." When a design question came up, the Committee threw it on the table, talked it over, looked at it from all angles (capital investment, manpower, maintenance, reliability) to arrive at the optimum design.

Its members, along with Braun people, made field trips all over the country. They'd visit a refinery, study a particular installation, and then take the operators off to one side and ask them just what changes they'd make (and what features they'd keep) if they were to redesign the unit today.

They didn't necessarily discard established practices, but they took a long, hard look at them and re-evaluated them before they decided to do the same thing.

The design of hose racks for loading and unloading tankers is a good example. In the past, usual practice has been to string the hose out on the dock, moving it into position with manpower and a boom. A Tidewater-Braun team was sent out to survey major oil ports and see if there wasn't some better way of doing the same job. As a result, they developed their own—a cradle arrangement which eliminates all manual hose handling. One man now handles the entire job of positioning a hose for loading or unloading a tanker—compared to the three or four men required for manual handling. And this one man does it faster (in a matter of a few minutes, compared to maybe as much as half an hour with the old system) and with a lot less wear and tear on the hose. (See pp 146-147 for more details.)

Three design policies were set up, in general:

1—Design a plant that would have maximum flexibility to run any type of crude from any source.

2—Keep combined unit investment and unit operating costs/bbl to a minimum.

This point dictated the use of maximum-size units and single large units instead of two or more duplicate smaller units. There are some differences of opinion, of course, as to the wisdom of putting all your eggs in one basket. Tidewater's view, however, was that the operating economics of single large units plus the lower investment cost per bbl more than offset any risk. Besides, they designed extra corrosion protection and spare parts into the single units. This reduced to a practical minimum the chances of any unexpected interruption in operations.

3—Provide facilities which will give superlative quality

a somewhat novel philosophy . . ."

products—not just for today's market. The Tidewater refinery is capable of producing 100% of all gasoline it manufactures as 100 octane plus—"of the highest purity and power yet known for the automobiles of today and tomorrow," according to Tidewater officials.

It can also turn out a No. 2 fuel oil with a sulfur content far below that required today, starting with a crude containing the highest sulfur content. Neither of these levels of quality are needed today, of course, but the capacity to reach them is there in this refinery of tomorrow.

Putting a new 130,000 b/d refinery onstream

Startup was unusual in the sense that everything was brand new—there were no units running. Everything had to be integrated from the start to finish. Since it was impossible to complete every unit on any one day, each unit had to be scheduled for completion and put on stream in a certain order.

Overall startup was in three stages:

1—Get the basic refinery in operation—with the crude unit, cat cracker, gas plant and poly plant on stream. This might not make money but would produce a product that would sell.

2—Bring up the product quality—with reforming and alkylation. Then the refinery would be in a competitive position.

3—Add the crude economies—with coking and desulfurization. Then you can charge the most economical crude and get the best product distribution, yield and quality. And then you are in business, operating the "Refinery of the Future."

What's in this Tidewater report?

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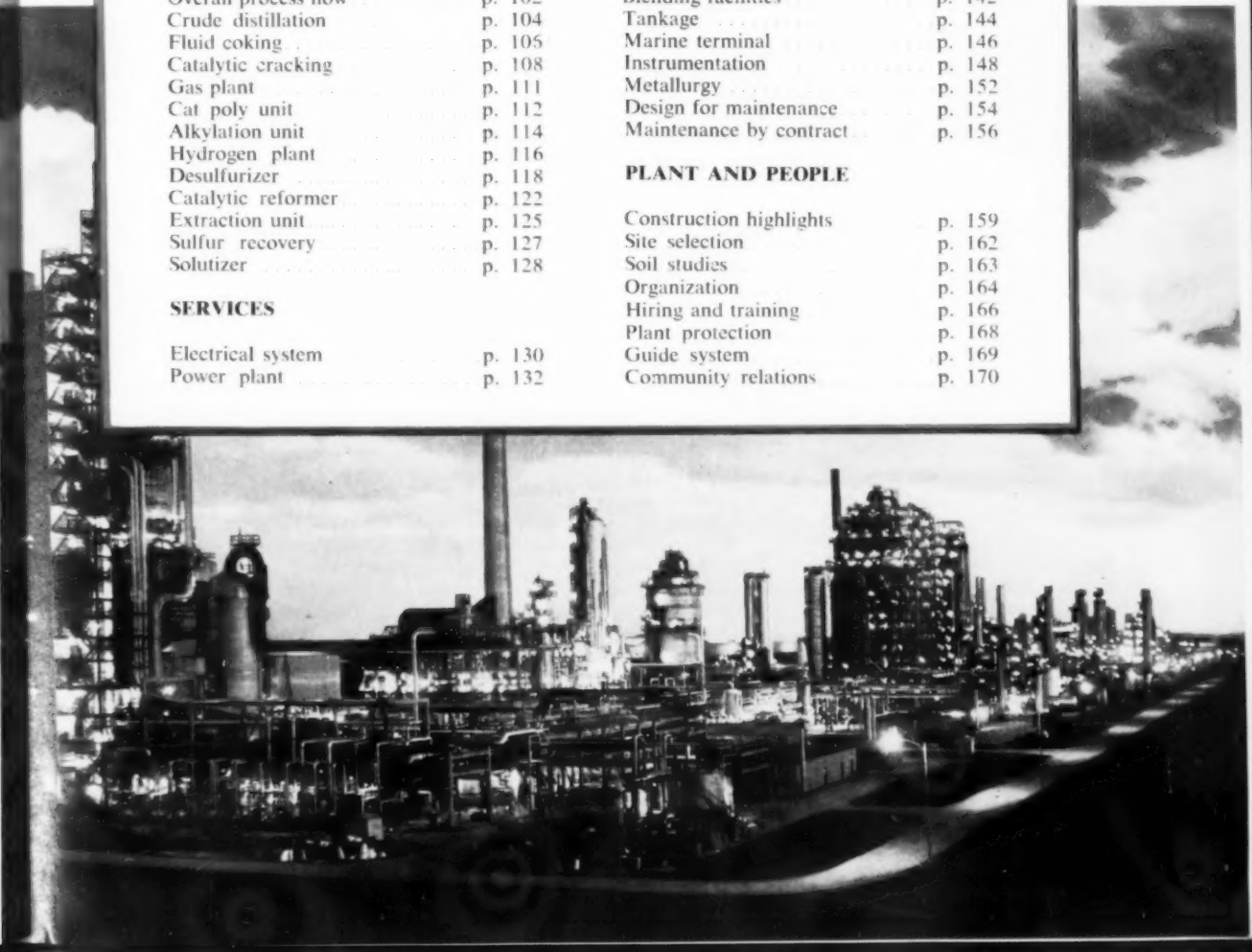
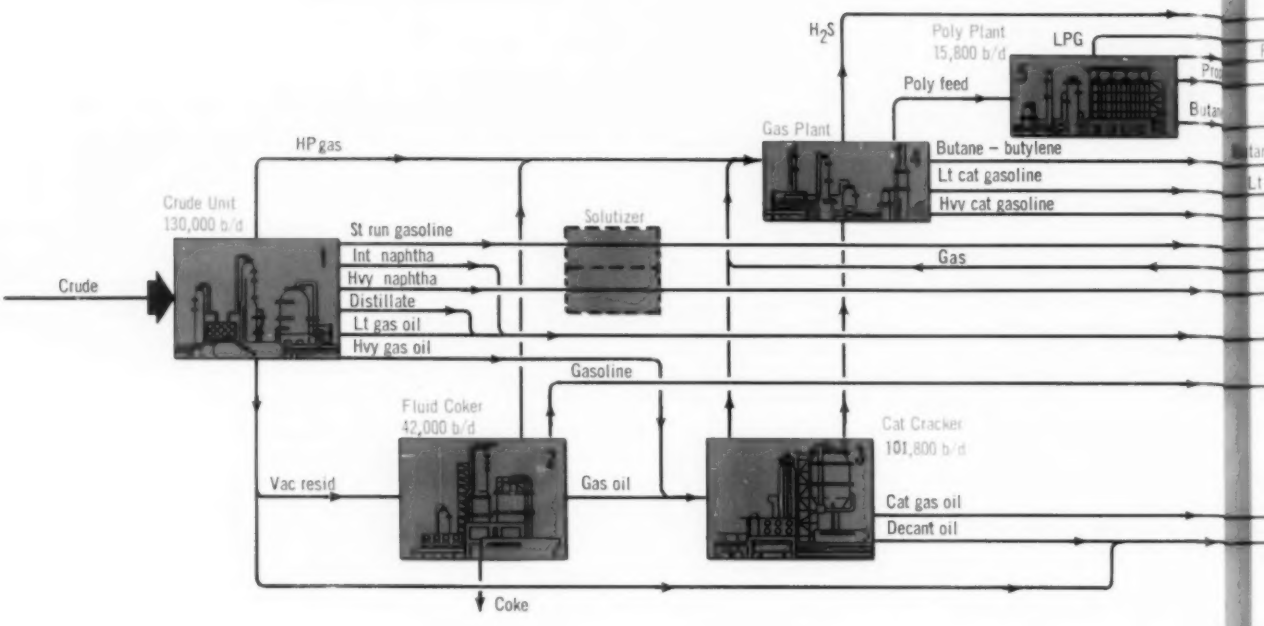


TIDEWATER PROCESSES

". . . economics



THIS PROCESS FLOW represents application of the latest technological developments to the ne

OVERALL PROCESS

By T. H. ANDERSON
Project Manager
C. F. Braun & Co.

THE history of modern petroleum processing shows a steady search for increasing profit margins in the face of rising costs. Gasolines and middle distillates are the high-realization products. These more than pay the operating costs and their share of the barrel of crude. Residual fuel oil is a byproduct. As such, it rarely pays its share of the barrel of crude. To show a profit, the refiner must realize more from gasoline, distillates and residual than cost of crude plus operation.

Sulfur was once the bugbear of the refiner. It forced him into acid treating to make his gasolines and middle distillates salable. This operation was expensive—he lost volume, and part of his distillate disappeared in sludge. High-sulfur, low-gravity crudes were so much bunker fuel. As such, they yielded a minimum price.

Tidewater's Delaware Refinery represents the latest technological developments in the industry for processing any crude oil, regardless of sulfur content or naphthenic acids. The processes were carefully evaluated. Economic studies showed it was not only possible to refine high-sulfur crudes economically but that the heavy high-sulfur crudes offered the larger profit margin.

Next came the combined question of capital costs and operating expense. Duplicate units would require duplicate investment, duplicate operating crews and maintenance, and some other additional expenses. Single large units involve some additional costs to provide the necessary built-in reliability. While this reduces some of the expected savings, still the duplicate route would have involved substantial increases in capital costs. With the steady increase in labor costs, the added operating labor made duplicate units even less attractive. All economics pointed clearly to large, single units with built-in reliability.

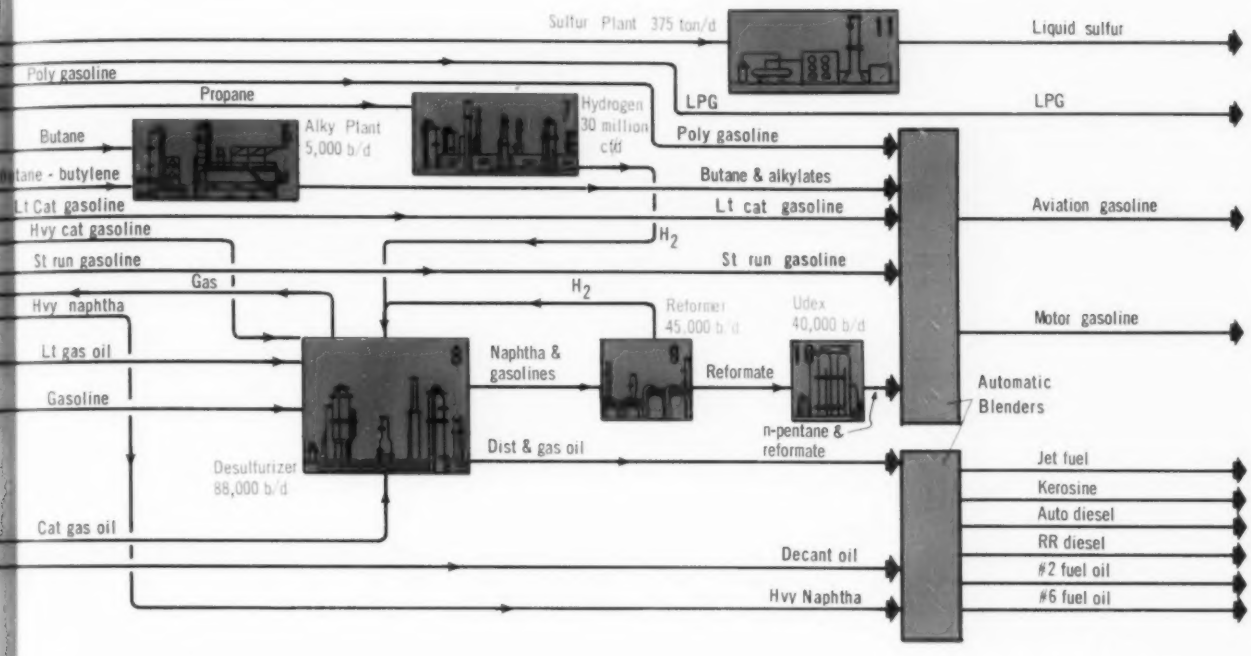
A constant threat in refining, where product quality has climbed continuously through the years, is obsolescence. Although today's products give a factual basis for process selection, a unit built today must be capable of meeting the increasing quality requirements of the years ahead. This prerequisite for a long, useful life was incorporated into the premises for process selection.

The Delaware Refinery is the result of the application of these fundamental premises. The accompanying refinery-flow diagram shows the processes selected in their relationship to one another. Unit by unit, here is how the basic premises were applied.

The first step in processing crude is the separation of its various fractions. For this, the largest crude unit in the world was designed and erected. It is capable of running 130,000 b/d of light or heavy crude. Petreco electric desalters remove the water and water-soluble salts from this entire charge. Light-gasoline fractions are final-treated and stabilized on the same plot. They leave as finished blending-stock.

The atmospheric crude tower separates the heavy gasoline and middle distillates into appropriate fractions for reforming, finishing, and blending. The 40-ft diameter vacuum tower

pointed to large, single units . . ."



of industry economics. Process selection was not limited by existing facilities

strips out the heavy gas oil for reprocessing by the catalytic cracker. Only metallic components and asphalt are left in the heavy black-oil bottoms.

The immediate reprocessing is in two steps, cracking and coking. The huge Orthoflow Fluid Catalytic Cracker has a design capacity for 102,000 b/d total feed. Here the heavy gas oil is catalytically broken down, yielding gasoline and No 2 fuel oil as the main products. This is the first big conversion of heavy, low-value fractions into high-realization products. What is more, it does a nice job of sulfur removal, but, with high-sulfur crudes, not enough.

The heavy bottom of the barrel has long been the blight in refinery economics. It could be visbroken and made somewhat less offensive. But it always required a sizeable amount of middle distillate to make it salable even as bunker fuel. The recent development of fluid coking afforded an attractive tool for the conversion of this least desirable material into high-value gasoline and middle distillates.

The fluid coker in the Delaware Refinery and its sister at Tidewater's Avon Refinery are the largest fluid cokers in the world. Each is capable of charging 42,000 b/d of heavy residuum. The coker makes gasoline, light gas oil, heavy gas oil feed for the cat cracker, and a small yield of fluid coke—a conveniently handled, marketable, solid fuel. It is this unit that puts an end to the refineries' black-oil problems and permits the economic refining of the low-gravity crudes.

Finishing of blending stocks was formerly accomplished by chemical treatment. This was costly. Little sulfur could be removed economically. The recent development of Unifining —the use of hydrogen for stabilization and desulfurization—afforded an economical means for refining high-sulfur crudes. The Delaware Refinery has an 88,000 b/d, five-train, Unifiner. This desulfurizing unit uses reformer and manufactured hydrogen to finish middle distillates from the crude-unit, cracker, and coker for final blends. It also cleans up the heavy gasoline for catalytic reforming. Propane is steam-reformed into hydrogen to make up shortages in reformer hydrogen when running very sour and heavy crudes.

Sulfur removed during desulfurizing and catalytic cracking comes off as hydrogen sulfide gas. The odors connected with this gas have at times been a public nuisance and a serious problem to refiners. By selective absorption it is removed from the waste gases. The high purity acid gas goes to the sulfur plant. Here by partial oxidation it is converted to liquor sulfur and is a source of income.

The increase of octane numbers and the stagnation of kerosene sales have made large volumes of heavy gasolines difficult to blend off into salable products. Catalytic reforming was the answer to this problem. In the Delaware Refinery, the 45,000 b/d Houdriformer lifts the low octane to high-octane fractions. The Udex unit takes them and separates the aromatic fractions for the tailormade gasoline of the future.

The story of the liquid products does not end here. Valuable light ends are produced in each processing and finishing operation. These are collected and processed in a single gas plant. This plant recovers 85% of the propane-propylene and all heavier fractions. It splits and treats the cat cracked gasoline for sulfur control.

The propane-butane fractions go to the polymerization and alkylation plants. This combined operation reduces the condensable fractions of these gases to high-octane liquids. In two integrated steps it gives the refinery both maximum liquid recovery and vapor pressure balance. Aviation alkylate from the alkylation plant is the prime base stock for the refinery's aviation-gasoline production.

TIDEWATER PROCESSES

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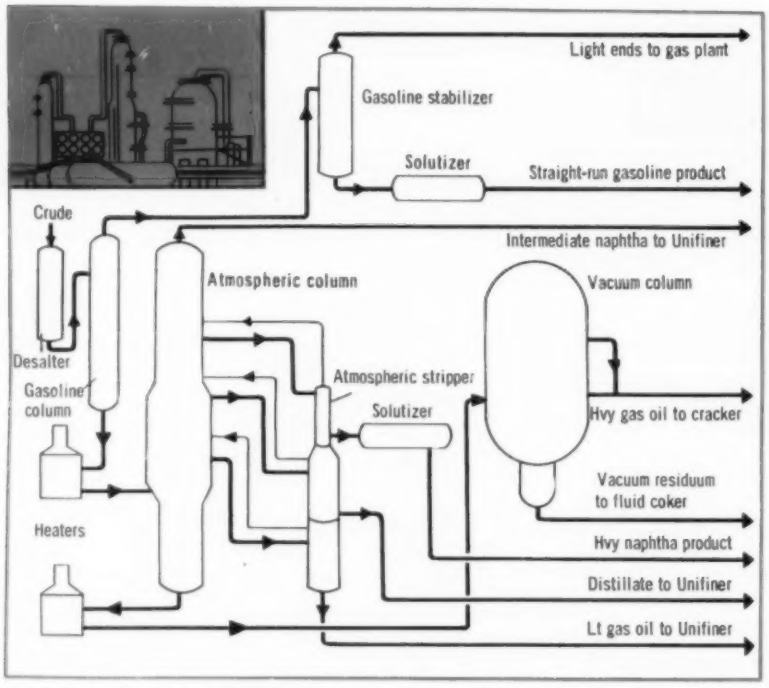


CONTINUITY OF OPERATION has been designed into this 130,000 b/sd unit

CRUDE UNIT

By W. E. COLBURN
Chemical Senior Engineer
C. F. Braun & Co.

THE keynote of Tidewater's 130,000 b/d crude distillation unit is broad flexibility—within the basic premises of safety, economy, and continuity of operation.

The world's largest, this unit will handle a variety of crude oils or blends of crudes, including sour stocks of any sulfur content or stocks containing naphthenic acids. It splits feed stock into the customary fractions—light ends, light straightrun gasoline, intermediate naphtha, heavy naphtha, virgin distillate, light gas oil, heavy gas oil, and vacuum residuum. Straightrun gasoline and heavy naphtha are treated onplot, ready for final blending. The other fractions go on to reprocessing.

Control of the feeds, both rate and blend, centers in the unit's control room. Three crudes can be line-blended at a time. Crude oil comes to the plot edge at about 340 psig and 60°F, is heated to 260°F, desalted, and then raised to about 400°F, all by heat exchange. Desalting, by electrical precipitation, is accomplished in a two-stage unit. The first stage has a single drum, the second, three drums piped in parallel—all four of the same size. Depending on needs, desalting may be two-stage, one-stage, or bypassed entirely.

Crude reaches the gasoline column at about 400°F, where straightrun gasoline and lighter components go overhead. The condensed product feeds the gasoline stabilizer, the vapor product goes to other units. The bottoms flow through exchangers and a fired heater to the atmospheric column. It's a whopper, 23 ft in diameter. It produces the usual overhead product, three sidestreams, and reduced crude bottoms.

Heat balance is maintained by two circulating sidestreams. Side products feed to individual sections of a stripper column. Light ends of each cut and the stripping steam return to the atmospheric column. The top sidestream, a heavy naphtha, gets a solutizer treat. The overhead product and the other two sidestreams are preprocessed further on. The steam-stripped bottoms are pumped through a fired heater and into a vacuum column.

The vacuum column is the largest in the industry—40 ft in diameter. It operates at about 750°F and 17 mm Hg absolute in the flash zone. Noncondensibles and stripping steam pass overhead at about 150°F. Two circulating sidestreams condense most of the hydrocarbon vapors and maintain the column heat balance. A single product, heavy gas oil, combines the net production of the sidestream.

The steam-stripped vacuum residuum, cooled to 450°F by exchange and steam generation, goes direct to hot storage, and becomes feed for the Fluid Coker. Vacuum is held by three-stage steam ejectors and shell-and-tube condensers. The condensers have divided water-boxes to facilitate tube-side cleaning on-the-run.

The overhead products from the gasoline stabilizer column feed to the gas plant. The bottoms product, a straightrun gasoline, feeds to the Shell solutizer, preparatory to final blending.

Waste-disposal facilities at the crude unit handle the entire refinery's foul condensate as well as the desalter water-effluent. The collected foul condensate is stream-stripped of its acid gas. The stripped vapors pass overhead, through a vapor line that is steam-traced and insulated to prevent condensation and resulting corrosion. The compressor section in the gas plant, and the desalters in the crude unit, re-use most of the stripped condensate.

Separate equipment strips and neutralizes the desalter water effluent. Sulfuric acid neutralizes the caustic, and flue gas from the cat cracker strips out the acid gases. Steam is hooked up as the standby stripping medium. Stripped acid gases from several sources are combined and are burned in the atmospheric-fired heater.

Corrosion protection is provided by an extensive variety of special mate-

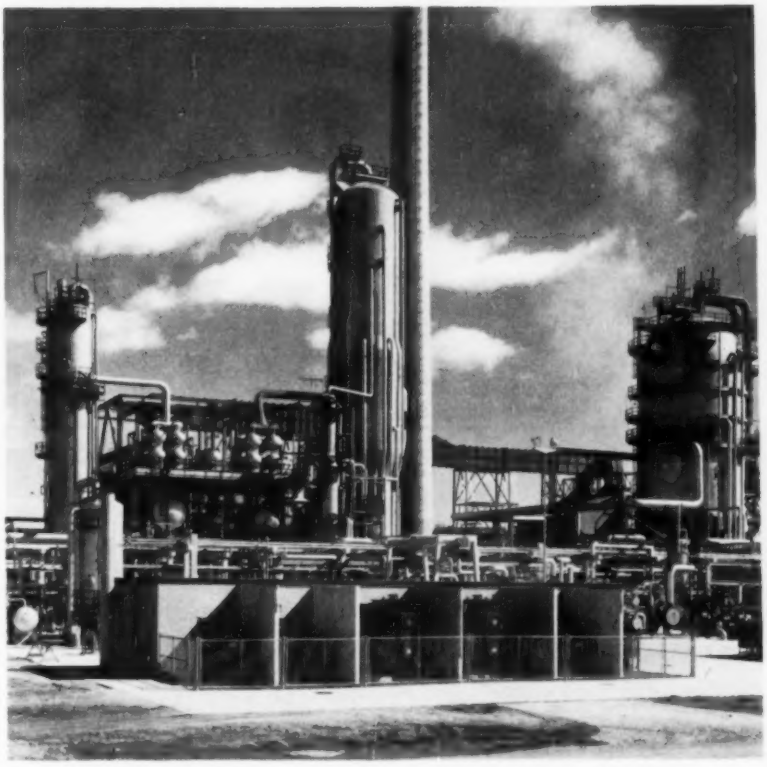
heater eliminates control valves"

rials including chemical inhibitors, ammonia and "Kontol." Ammonia helps protect the top section of the gasoline column, the atmospheric column, and each stage of the ejector system of the vacuum column. Kontol is used to protect the overhead duct from the atmospheric column and the ducts of the vacuum-column ejector system.

Monel provides protection in the top of the gasoline column, the overhead line, the condenser shells, the water draw-off pot and the foul condensate pumps. Similar protection takes care of the top two-thirds of the gasoline stabilizer column, its overhead line, and condenser shells. Inconel protects the bottom third of the stabilizer, the reboiler lines and the reboiler shellside.

Lining and internals of part of the atmospheric column, much of the vacuum column, and the light-gas oil stripper are of Type 316 ELC stainless steel. The same material is also used on the transfer lines between the fired heaters and the columns, and some of the hot pumps. Chrome steels are used for the fired-heater tubes and the hot process lines.

Several design features assure continuity of operation. Bypass lines around the gasoline column, around the gasoline stabilizer column, and around the vacuum column, permit the unit to operate when one or more of the towers cannot be used. Valving and bypass piping provide a means of shutting down the parallel banks within each exchanger service. Spare pumps in critical services have automatic pump starters. A pumpout system provides a way of emptying the equipment. Light and heavy pumpout streams are segregated. A seal-oil system keeps instruments operating that are in heavy, viscous services. Normally, a product line feeds the seal-oil system, but should the product pump fail, the standby equipment takes over.



CRUDE UNIT'S atmospheric column is 23 ft in diameter

The fired heater may be fueled by all fuel gas, or all fuel oil, or mixtures of each. And for the first time in any heater, provisions have been made for the future use of fluid coke.

Pump-speed controls the charge rate to each fired heater, thus eliminating process-control valves, in turn saving horsepower.

A closed blowdown system for relief protects most of the apparatus. The hot relief-vapors flow to a quench drum and are cooled to 200°F before going to the offplot flare. All liquids dropped to the oily-water sewer, flow to the large guard basins and API separator. Relief valves on the crude-oil supply header and on the desalter drums protect the apparatus against charge-pump shutoff head and fire. These relief valves discharge to the gasoline column unless it is down, they discharge to the atmospheric column.

Engineering, design and construction of the crude unit and its allied facilities were handled by C. F. Braun & Co.

Table 1—Basic design yields of crude unit

(Figures are in % of typical charge stocks)

	West Texas	Kuwait	Wafra-W. Texas Mix
Light ends	0.6	2.9	0.7
Straightrun gasoline	11.7	8.3	8.3
Intermediate napththa	17.0	15.0	7.5
Heavy naphtha	2.0	4.0	3.0
Virgin distillate	13.0	10.0	7.5
Light gas oil	15.0	10.0	8.5
Heavy gas oil	31.7	32.8	32.0
Vacuum resid.	9.0	17.0	32.5
Total	100.0	100.0	100.0

Table 2—Utility requirements for crude unit

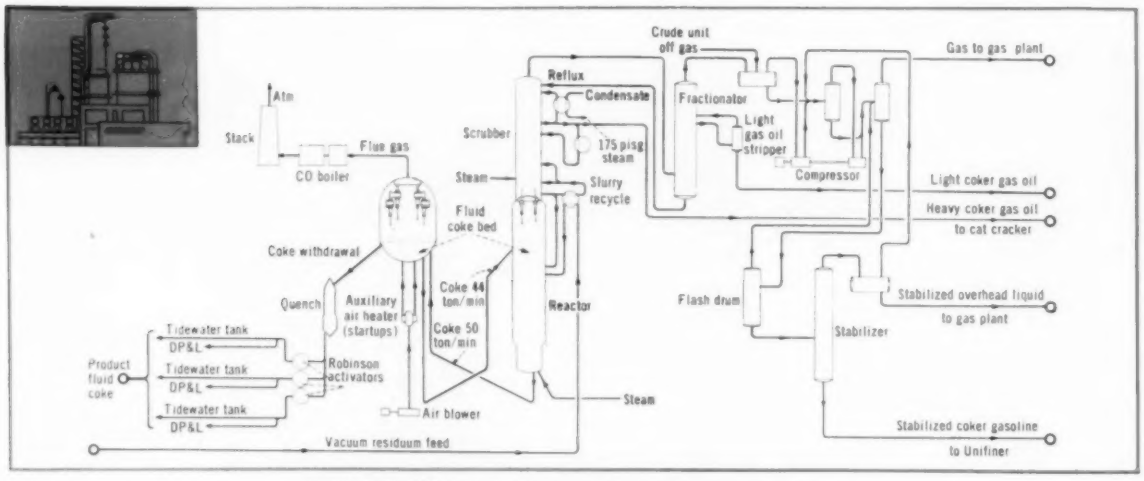
Cooling water, gpm.	23,000(1)
Steam needs, lb/hr	
40 psig.	108,500
175 psig.	23,500
Power, KW	1,700
Fuel, lb/hr	
100% gas	30,000
100% oil	29,500
50% coke	18,800(2)

(1) About half the water is used in more than one service.

(2) This figure is for a future condition when coke burning facilities are installed. About half the duty will be supplied by gas or oil.

TIDEWATER PROCESSES

"... reactor holds 600



FEEDSTOCK here is bottoms from the vacuum tower

FLUID COKER

By ROBERT L. DAVIDSON
Associate Editor
PETROLEUM PROCESSING

A "TWIN" to the world's largest Fluid Coker is now starting up at Tidewater's Delaware refinery. This 42,000 b/sd unit (same capacity as Tidewater's Fluid Coker at Avon, Calif.) was designed to give a minimum production of heavy fuel oil at Tidewater's Delaware refinery.

Use of the Fluid Coker, licensed by Esso Research & Engineering Co., and engineered, designed, and built by C. F. Braun & Co., helps process the lowest cost crudes, yet gets a high yield of valuable products.

Some of the coke produced will be for sale, but a large amount of it has been contracted for by Delaware Power & Light Co. to use as fuel at its adjacent power plant.

Coker operation: Feedstock for the Fluid Coker is 42,000 b/sd of vacuum tower bottoms, which enters the reactor and is sprayed onto coke particles already in the reactor. The liquid feed remains on the fluidized coke particles at about 950°F until it thermally cracks to lighter materials and more coke.

Light materials formed in the reactor flow upward through cyclone separators, then into the scrubber tower on top of the reactor. Fluid coke made in the reactor, plus recycle coke, is sent to the coke burner via a circulation line.

The scrubber part of the reactor-scrubber separates the coker light ends into heavy coker gas oil for cat cracker feed, and an overhead product which is sent to a fractionation and stabilization train.

A portion of the heavy gas oil withdrawn from Esso "Jet Trays" in the scrubber serves as reflux in the scrubber system.

Part of the coke-oil slurry collecting in the bottom of the scrubber is recycled to the reactor near one of the fresh feed points. The remainder is recycled to shed trays in the lower section of the scrubber.

The coke burner furnishes about 400 million Btu/hr of heat to the reactor by burning about 20% of the gross coke made (about 5 wt-% of the feedstock) and circulating 44 ton/min of 1125°F coke back to the reactor. A 6870-hp centrifugal blower furnishes 100,000 SCFM of combustion air to the burner.

A number of 2-stage cyclones at the top of the burner eliminate most of the coke fines from the overhead burner flue gas. Even so, about 8 ton/day of coke fines pass out of the top of the burner, along with appreciable amounts of carbon monoxide, and are sent to the Babcock and Wilcox CO Boiler.

If the burner is not in operation, the CO boiler can be fired on fuel oil or gas to generate 210,000 lb/hr

Table 1—Ultimate product distribution from Fluid Coker
(Based on original design data)

	°API	Sulfur, wt-%	Total wt-%	Total vol-%
Vacuum residuum feed[1]	2.5	5.5	100.0	100.0
Coker products				
C_3's and lighter	—	—	9.5	—
C_4's (butanes & butenes)	—	—	1.87	3.30
Gasoline (C_5-400°F)[2]	55.5	0.75	12.51	17.47
Light gas oil (400-640°F)	27.5	3.4	10.07	11.95
Heavy gas oil (640-1015°F)	12.5	4.17	39.55	42.51
Coke (gross make)[3]	—	8.25	26.5	—
Gross liquid recovery (C_4-1015°F)	—	—	—	75.23

[1]Con carbon 24%. [2]75-80 RON clear, high in unsaturates. [3]Net coke make about 1600 ton/day for 42,000 b/sd feed to unit.

tons of fluidized coke in operation"

of 600 psig (750°F) steam. When the coker and burner are operating, steam production is 426,000 lb/hr.

Net coke product from the burner is cooled and sent through three lines to Robinson Activators. These activators "batch" the coke to the 6000-ton Tidewater coke silo, or through transfer lines to the three 1070-ton coke silos at Delaware Power & Light Co.'s adjacent power plant.

Each activator fills until it holds three tons of coke, then closes off from the burner product coke line. The activator receives 100 psig air, sufficient to elevate the fluid coke to the storage silos.

Fractionation and stabilization of overhead product from the scrubber section (following the reactor) produces gas for the gas plant, light coker gas oil for the cat cracker or Unifiner, stabilized overhead liquid for the gas plant, and stablized coker gasoline for the Unifiner.

Construction highlights: The overall height from grade of the scrubber-reactor is 250 ft, the tallest process unit in the refinery. The bottom reactor portion has an overall height of about 135 ft, with its largest diameter about 29 ft. During operation, the reactor holds about 600 tons of fluidized coke.

The shells of the reactor, scrubber and burner are refractory-lined carbon steel. The scrubber shell is clad with Type 316 ELC stainless. The air distribution system in the burner and the cyclones at the top of the reactor section are 12-Cr stainless steel.

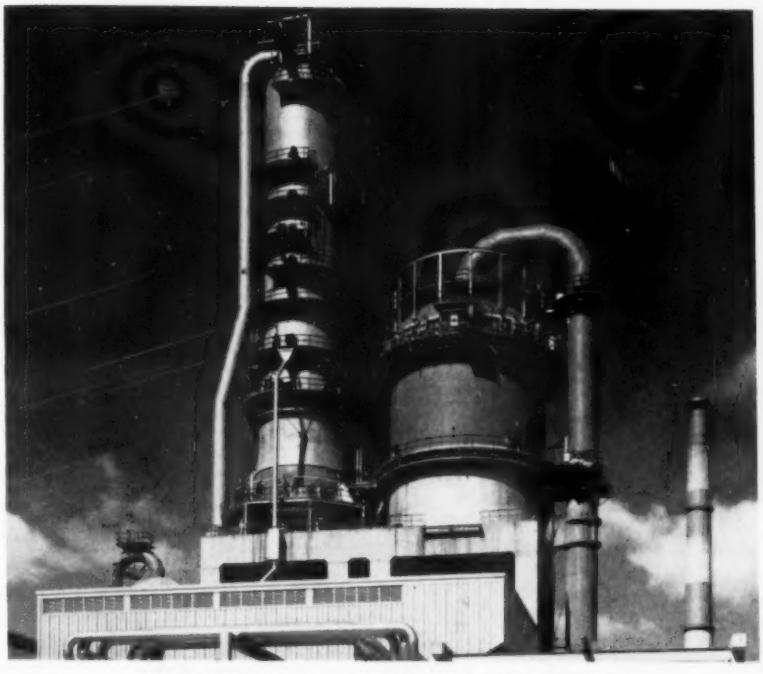
Numerous steam injection points in the coke circulation lines keep the coke fluidized and moving.

Fluid Coker products: To date, operating experience is too brief to give exact yield and quality data for the unit. Information available is based on design data, assuming one of the worst possible crudes expected at this refinery (but not the crude currently being produced).

Ultimate product distribution is shown in Table 1 for a vacuum residuum feed with 24% Con carbon, 2.5° API, and 5.5 wt-% sulfur. For a feed rate of 42,000 b/sd, net coke will be about 1600 ton/day.

The heavy coker gas oil is sent to the cat cracker without pretreat. Light gas oil can go either to the cat cracker, or to a Unifiner for desulfurization. Coker gasoline is sent to the Unifiner-Houdriformer-Udex system. Fluid coke goes partly to Tidewater storage for future disposition, and partly to the coke storage silos at Delaware Power & Light Co.'s power plant. The C_4's are rich in unsaturates, and are sent to the gas plant to make a separation for alkylation unit feed.

Utilities: Utilities needed for the fluid coker at Tidewater's Delaware refinery are given in Table 3.



EIGHT MEN operate this 42,000 b/sd Fluid coker

The author acknowledges his appreciation to those who supplied information for this article: E. J. Hoffman, technical foreman, coker, Delaware Tidewater Oil Co. refinery; J. A. Whitcombe, process senior engineer, C. F. Braun & Co.; P. H. Holt, II, manager, process licensing, and R. L. Dunne, public relations, Esso Research and Engineering Co.

Table 2—Fluid coke properties

(Based on original design data)

Sulfur, wt-%	6-8[2]
Volatile matter (950°F), wt-%[1]	5-7
Gross heating value (dry), Btu/lb	14,000-16,000
Carbon, wt-%	91-94
Ash, wt-%	0.2-0.5
Vanadium, ppm	600-800[2]
Nickel, ppm	Not known
Ash fusion, °F	2500-2900[2]
Apparent bulk density, lb/cu ft	55-65
Angle of repose, degrees	30
Moisture, wt-%	0.3-0.6

[1]Volatility is low, therefore the fluid coke must be pulverized more finely than coal for use in boiler plants. [2]Varies with the crude source.

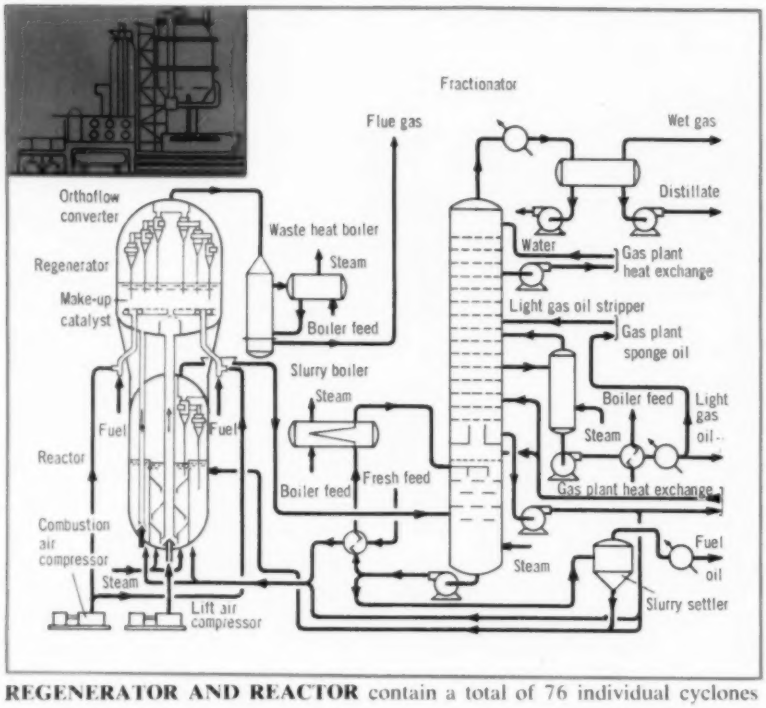
Table 3—Utilities used for Fluid Coker

(Based on original design data)

Steam make, lb/hr:	
600 psig	426,000
175 psig	195,000
40 psig	60,760
Steam take, lb/hr:	
600 psig	177,435
175 psig	86,322
40 psig	124,200
Power, motor bhp	1,100
Fuel gas (F.O.E.) for CO Boiler, lb/hr[1]	16,000
Cooling water, gpm	24,700
Demineralized water for CO boiler, gpm	840
Treated water for steam generation, gpm	493

[1]For periods when flue gas from coke burner not available.

"... valves control



REGENERATOR AND REACTOR contain a total of 76 individual cyclones

CRACKING UNIT

By L. F. RICE
M. W. Kellogg Co.

THE Orthoflow fluid catalytic cracking unit in Tidewater's Delaware Refinery is the largest such cat cracker in the world. The unit was designed by The M. W. Kellogg Co. and constructed by C. F. Braun and Co. Oil was first charged to the reactor on November 4, 1956. Operations to date have been at throughputs up to 103,000 b/sd.

The main purpose of this unit, like most cat crackers, is to convert gas oils to high octane gasoline. Various by-products produced are feed stocks to other processing units. Isobutane and butylenes are charged to sulfuric acid alkylation. Propylenes and excess butylenes are catalytic polymerization feed stocks. Light gas oil produced in the cat cracker flows through the desulfurizer to No. 2 fuel oil blending. A bottoms stream, after settling to remove catalyst fines, flows to the refinery and boiler fuel-oil system. Heavy catalytic gas oil is recycled to extinction in the cracker.

The unit feed consists of mixed virgin and fluid coker gas oils. Design yields are based on the refinery processing a mixture of Kuwait and West Texas crudes. These anticipated yields at capacity are summarized in Table 1.

The Orthoflow converter is the principal piece of equipment within the cracking unit battery limits. This converter combines in one vessel the facilities for cracking, stripping, regeneration, and catalyst circulation. The lower section is the reactor, which also contains the catalyst stripper. The regenerator is mounted on top of the reactor.

Table 1—Design operations at 900°F with synthetic catalyst

Fresh feed, 23.3° API, b/sd	58,000
Recycle, 20.0° API, b/sd	43,800
Throughput, b/sd	101,800
Products:	
Propane & lighter, lb/hr	65,040
Butanes, b/sd	7,877
Debut. gasol., 56.6° API, b/sd	29,120
Light gas oil, 24.4° API, b/sd	18,690
Fuel oil, 5.0° API, b/sd	1,623
Coke, lb/hr	51,130

Regenerated catalyst flows directly from the regenerator bed through the straight standpipes into the reactor bed.

Spent catalyst enters the stripper from the reactor through slots in the partition which separates the two zones. Stripped spent catalyst is conveyed by air up to the regenerator through the straight riser pipes. Streamlined plug valves are used throughout to regulate the flows of catalyst to and from the regenerator.

Spent catalyst and lift air are delivered through a distribution grid to the regenerator bed. Most of the air required to burn off the coke laid down during cracking enters the bed through two air distributors. Each of these air inlets is provided with an air heater for use during startup. Above the bed the flue gas leaves the vessel through three-stage cyclones for catalyst recovery. Emergency cooling is available through water sprays located above the catalyst bed near the first-stage cyclone inlets.

Regenerated catalyst and oil feed enter the reactor separately. As mentioned above, catalyst enters the bed directly from the standpipes. Oil is injected through some nozzles in the bed below the standpipes. Two stage cyclones are provided to recover catalyst entrained in vapors leaving the bed.

The spent catalyst stripper is divided into cells, each provided with a separate catalyst feed slot and steam spider. In addition, baffles have been installed in order to maximize the stripping efficiency. The stripped vapors join the effluent reactor vapors above the bed, and exit via the reactor cyclones.

Two catalyst storage drums are included. The used catalyst drum is sized to hold the maximum unit inventory of about 1800 tons. The other drum, for fresh catalyst, has a capacity of 500 tons. Provisions have been made for continuously adding catalyst from the fresh catalyst drum to the regenerator to make up flue gas stack losses.

Two turbine-driven, centrifugal air compressors provide the air for cat-

90 ton/min of catalyst flow"

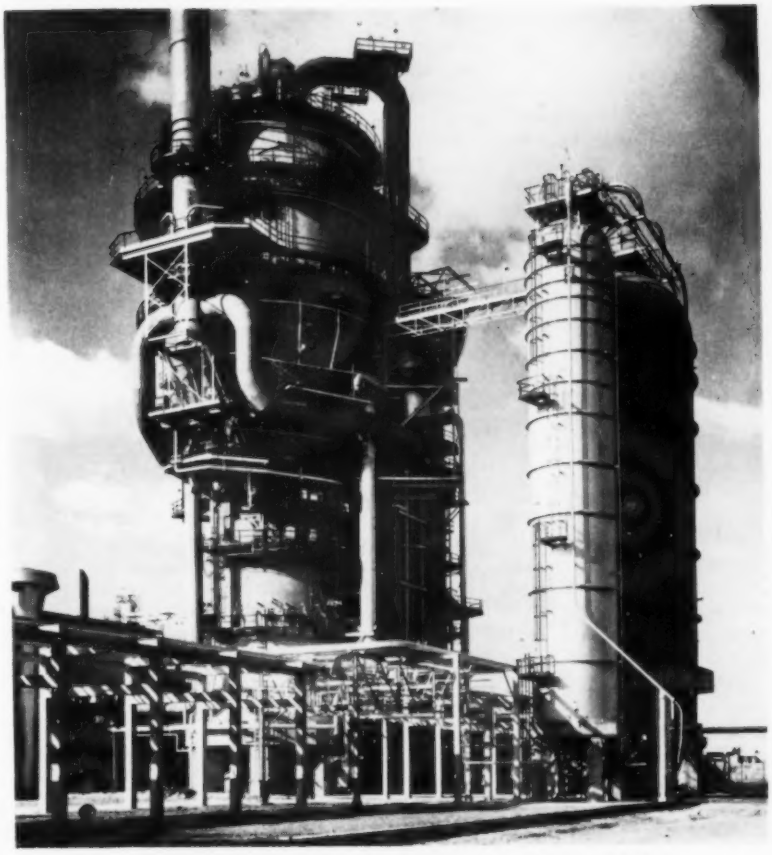
alyst regeneration. The smaller of the two supplies air for transporting catalyst through the risers from the stripper to the regenerator, the air being introduced into the lines through the hollow stems of the plug valves. The other compressor supplies most of the combustion air directly to the regenerator bed, entering through two distributors.

Waste heat is recovered from the regenerator flue gas by generating 175 psi steam in two waste heat boilers. The cooled flue gas from the two boilers is vented to atmosphere through a common stack.

Primary product separation equipment is included in this unit and consists of a fractionator tower, gas oil stripper, and a slurry settler. The fractionator produces wet gas and 430°F end point overhead streams, both of which flow to the gas recovery unit for further fractionation into gas, propane-propylene, butane-butylene, and gasoline. Light gas oil is withdrawn, stripped, cooled, and sent to the desulfurizer. Heavy gas oil is recycled to the reactor. A bottoms stream is fed to the slurry settler. The thickened slurry from the bottom of the settler is returned to the reactor bed bringing back catalyst which escaped the reactor cyclones. The decanted oil, virtually powder-free, flows from the top of the settler through a cooler to refinery fuel oil storage.

Four circuits provide reflux for the fractionator. These circuits supply heat for reboiling the gas recovery unit, preheating fresh feed to the reactor, and generating 175 psi steam. Top tray and heavy intermediate reflux circuits are the sources of reboiler heat for the recovery unit towers. A slurry reflux circuit provides feed preheat and generates steam in the slurry boilers. The fourth reflux stream is light gas oil which serves as sponge oil in the recovery unit. The cat fractionator also serves as the rich sponge oil stripper with the stripped vapors returned to the recovery unit as part of the wet gas.

"Bigness" is the outstanding characteristic of this unit, with the gigantic Orthoflow converter overshadowing everything else. The overall height of this vessel is nearly 170 ft. The regenerator has a diameter of 60 ft. Sixty individual cyclone separators are installed in the regenerator. The reactor contains sixteen. The Orthoflow plug valves are duplicates of the largest valves in similar services. A multiplicity of standpipes and risers was resorted to rather than development of new valve designs approximately twice as large as any in existence. These valves have to control the catalyst flow at a circulation rate of nearly two carloads per minute! Incidentally, it takes 33 carloads of catalyst to provide the maximum operating inventory in this huge unit.



HEIGHT of the cat cracker converter is almost 170 ft

BOTTOM SECTION of cracking unit during construction

The combustion air compressor is the largest ever used for this service. A condensing turbine capable of delivering 11,250 brake horsepower is required to drive it. The lift air compressor requires an added 3000 bhp.

The 25-ft diameter fractionator

tower is believed to be the largest tower in this service. Multi-flow bubble trays are used to assure proper functioning of the column.

Costly construction materials have been avoided as much as possible. Despite its large size, the Orthoflow converter shell is carbon steel. So too are the cyclones and most of the internals. Carbon steel is used throughout the reactor.

The entire lining of both the reactor and the regenerator is pneumatically applied. The lining minimizes shell temperature and, as a consequence, metal thickness. The layer next to the shell is a special insulating concrete. The layer exposed to catalyst is made of refractory concrete reinforced with hexsteel.

First stage reactor cyclones and all regenerator cyclones are provided with an inch-thick refractory concrete lining reinforced with hexsteel to minimize erosion damage. Similar linings have been installed in the catalyst standpipes and risers.

The fractionator tower too is carbon steel. The lower portion of the column, from above the recycle draw-off pan, is provided with an 11-13% chrome-clad plate for corrosion protection. The trays and internals in this section are also alloy. The rest of the internals are carbon steel. All of the alloy trays are fabricated from lightweight pressed plate.

Design problems—any plant larger than its predecessors poses problems in design. Processwise, the chief concern here was how to be assured of uniform gas flows across the large cross sectional areas of the reactor and regenerator.

The problem was solved by use of a relatively large number of oil inlets together with the multiple standpipes. In the regenerator two combustion air inlets were used, with each one connected to two perforated distributors to assure uniform velocities.

The mechanical design of the converter and its support presented more difficulties. Positioning of the waste heat boilers and the flue gas stack was the subject of a great deal of careful investigation. These items, like most equipment in this plant, are the largest of their types ever built. The problem was to support them symmetrically off the converter without producing excessive eccentricity in the foundation load. To save converter height and excessive catalyst loads a special elliptical bottom head had to be designed for the regenerator. In previous designs hemispherical heads had always been used in large converters.

A major consideration in the converter design was to avoid metal thickness which would require stress relief after field fabrication. This was of particular concern in the bottom head of the reactor. In the final design it was necessary to restrict the water testing of the reactor and regenerator to one section at a time in order to avoid such a stress relief requirement.

All equipment stands on reinforced concrete pedestals. Structural steel use is limited to the stair and elevator structure and equipment and platforms attached to the major vessels. Wherever possible the practice of utilizing the structural value of the larger vessels for supporting platforms, piping and subsidiary equipment was followed. Yard piping is carried on supports fabricated from precast concrete sections.

Design of the Orthoflow reactor-regenerator vessel support was probably the biggest engineering problem encountered. The maximum load to be supported was 19-million lb. The resulting hexadecagon space frame supported on eight columns is believed to be unique. The sixteen beams are 6 ft sq, the columns are 5. A total of 1106 cu yd of concrete and nearly 140 tons of reinforcing steel are required for this structure and foundation.

The other large towers and drums stand on more conventional octagonal space frames supported by columns.

The selected job site offered unusually good soil conditions, having a bearing value of 10,000 lb/sq ft. As a result, foundation designs presented no particular difficulties in spite of the great weights involved.

Built-in servicing facilities have been included wherever experience has shown that equipment is normally removed for inspection or repair at each turnaround. Such facilities were given due consideration in laying out the plot. The Orthoflow plug valves, stack valve, expansion joints, and similar items situated above grade, can be removed and lowered to grade with one, or at most two handlings. A 151-ft high elevator for hauling light freight, tools and personnel is also included in the layout. All such facilities are designed to reduce shutdown time to a minimum.

Although total utilities consumption is bound to be high in a unit of this size, the plant is an overall steam producer. Most pumping services are steam drive, exhausting at 40 psi to make process steam, or alternately motor driven. Thus the net production of 175 psi steam and consumption of 40 psi may be varied to suit the refinery balance. Table 2 shows utility balances for the two extreme cases: maximum turbine drives and maximum motor drives.

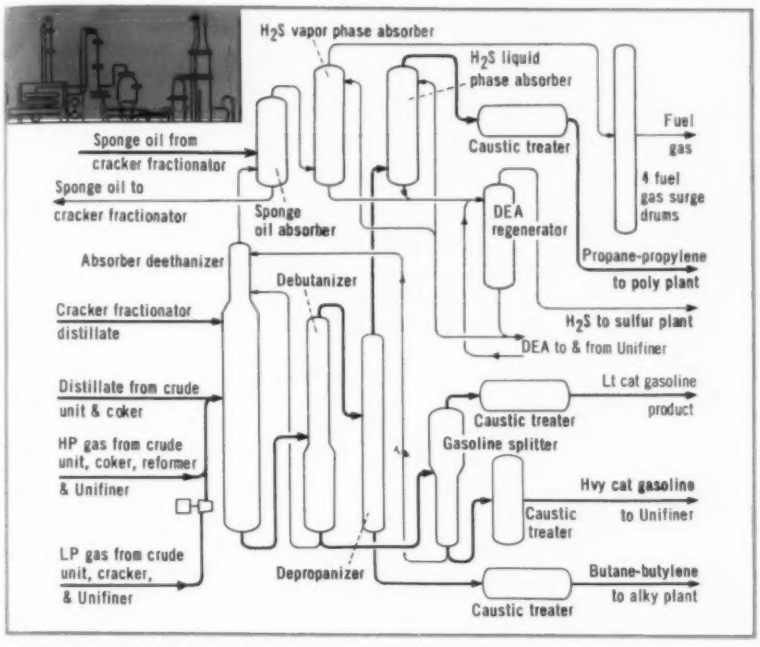
With practically all process variables on automatic control, manpower requirements here are about the same as on smaller units of similar type. Operation is under direct control of a shift leader who is also responsible for the gas plant. Under him and assigned to the cat cracker are three operators per shift. There is also usually an operator trainee who assists the operators on both units.

In spite of the size of the cat cracker, no new operational or maintenance difficulties are anticipated. Turnaround manhours must of necessity be greater than for smaller units because of the large size or greater number of pieces, such as cyclones, requiring service. With the consideration given originally to expediting equipment removal, the non-productive downtime can be minimized. All in all, operational efficiency in excess of ninety percent is expected.

Table 2—Utilities summary for two types of drive

	Max. turbine drive	Max. motor drive
Throughput, b/sd	101,800	101,800
Steam:		
575-psi, 150°F., lb/hr	105,000	105,000
175-psi, saturated, lb/hr	86,000	36,000
40-psi, saturated, lb/hr	0	50,000
Total consumption, lb/hr	191,000	191,000
Total production, 175-psi, lb/hr	254,000	254,000
Net production, 175-psi, lb/hr	168,000	218,000
Electric power, kwh	0	1,150
Cooling water, gpm	18,000	18,000

"... hoisted 356 tons"



DISTILLATION COLUMNS get 220 million Btu/hr of reboil heat from cracker

GAS PLANT

By H. A. BAIRD
Project Senior Engineer
C. F. Braun & Co.

TIDEWATER'S gas plant serves as a light-ends recovery, cleanup, and treating unit for the entire Delaware refinery. It takes liquid and vapor feed streams from five different process units, and produces two vapor and four liquid products. Its capacity is 88-million cu ft daily.

Vapor products are sweet gas for the refinery fuel system, and hydrogen sulfide for the sulfur plant. The four liquid products are a propane-propylene cut for poly-unit feed, a butane-butylene cut for alkylation-unit feed, light cat gasoline for product blending, and heavy cat gasoline to feed Train 3 of the desulfurizer.

There are three main sections: 1) a conventional absorption and distillation section, 2) a hydrogen-sulfide removal section, and 3) a treating section for caustic washing and inhibitor sweetening.

Like several other units in the refinery, this unit is the largest single unit of its kind in the U.S. Some of the fractionation columns are the biggest ever used for their services. The 356-ton absorber-deethanizer, for example, was the heaviest column-lift ever recorded. To furnish reboil heat for each of two large columns, the debutanizer and the DEA regenerator, there are three parallel kettle reboilers, each with 17,000 sq ft of surface.

Feed to the absorption and distillation section consists of low-pressure gas, high-pressure gas, and gasoline cuts from the other units. The low-pressure gas is compressed and sent to the absorber-deethanizer along with the other two feed streams. The absorber-deethamizer and sponge-oil absorber are designed for 85% recovery of propane-propylene.

In the H_2S removal section, absorber dry gas, high-pressure sour gas from the desulfurizer, and propane-propylenes from the depropanizer are contacted with diethanolamine solution in vapor and liquid phase absorbers where hydrogen sulfide is removed. Lean DEA absorbent also goes to a vapor phase absorber in Train 5 of the desulfurizer. Foul DEA returns, is combined with the DEA from the two gas-plant absorbers, and then is regenerated in a large single column. A cleanup column and filter operate continuously on a slipstream to keep the DEA solution active.

In the treating section, single-stage and two-stage caustic wash systems treat poly feed, alky feed, and light cat gasoline. Antioxidant inhibitor, air, and doctor solution are added to the light cat gasoline for sweetening. Heavy cat gasoline is caustic washed in a two-stage treater equipped with electric emulsion breakers.

The gas plant is located near the center of the process area because it is a single facility serving the entire refinery. It is combined with the catalytic cracking unit on a single plot to effect savings in both initial cost and operation cost. The most important of these savings is in heat recovery. The gas oil streams from the cracker-fractionator provide some 220-million Btu/hr of reboil heat for the gas plant distillation columns.

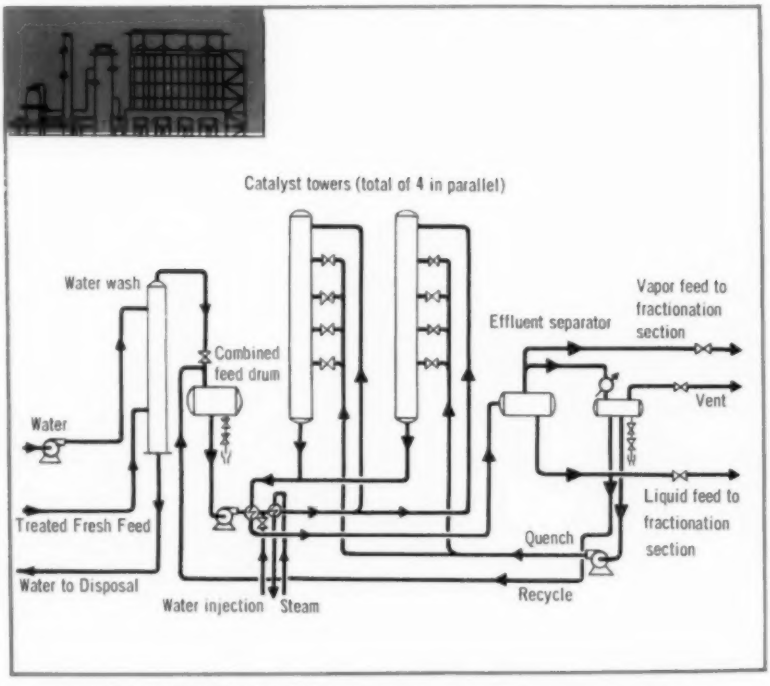
Other savings are realized in the piping, structures, and buildings. Because the cracker is the largest gas producer in the refinery, locating it adjacent to the gas plant keeps piping length and sizes to a minimum. Both units are served by a common control house and common switchhouse.

The common plot offers operating and maintenance advantages for the large centrifugal machines. The cracker-regenerator air-blower, the catalyst carrier-line blower, and the two gas plant compressors are all located on a single elevated operating floor. These machines represent a total of some 28,000 hp. The large suction and discharge piping is brought under the floor, leaving the operating level clear for operation and maintenance. One overhead crane serves all four units.

The two gas compressors normally operated in parallel are multi-stage centrifugals with direct steam-turbine drives. Each is rated for 60% of total design capacity and powered for 70%. The extra design horsepower is provided primarily for emergency operation with one compressor down and the other operating at maximum capacity. The turbine drivers, selected for steam balance, use 600 psig steam exhausting at 40 psig back pressure.

All of the facilities were process engineered, designed and built by C. F. Braun & Co.

"... large capacity CAT POLY UNIT



THIS UNUSUAL DESIGN results from special processing needs

By D. P. THORNTON, Jr.
Universal Oil Products Co.

THE UOP solid phosphoric acid polymerization unit designed for the Tidewater refinery at Delaware City is one of the largest units of its type ever constructed. As a result of the special processing requirements at this refinery, its design departs significantly from the standard design usually employed. A chamber-type unit including the most modern developments, designed by Universal Oil Products Co. and engineered and constructed by C. F. Braun & Co., it has a fresh feed capacity of 15,850 b/sd of a mixture predominating in C_3 and C_4 hydrocarbons.

The unit is designed to charge all of the available C_3 hydrocarbons in the refinery. Since the plant has an alkylation unit, only those C_4 hydrocarbons not committed to this unit are included in the charge to polymerization; i.e., the polymerization of C_4's amounts to a "trim" for the alkylation unit's isobutane-butylenes requirements. Thus, there undoubtedly will be occasions in actual operations when the feed to polymerization will contain only C_3's. However, when the alkylation unit is down for maintenance, the poly plant will be capable of handling most of the refinery production of C_3-C_4 hydrocarbons as a consequence of suitably altering overall processing operations in the refinery as well as those at the poly unit.

The catalytic polymerization unit as designed by UOP consists of a water wash column, four chamber-type reactors, a reactor effluent separator and a surge drum. Feed pretreatment facilities other than washing, and the customary fractionation facilities normally included in the standard UOP design were in this instance designed by Braun.

The process flow is shown schematically. Water wash is employed to remove any remaining impurities in the feed. (Previous to water washing, the feed will be amine desulfurized and caustic scrubbed at the refinery gas plant.)

Provisions for water injection have been made in order to maintain the desired hydration of the solid phosphoric acid catalyst. The charge is heat exchanged against reactor effluent with final control of inlet temperature by a steam-heated preheater.

One of the most unusual features of the unit is the employment of four reactors, in parallel, each designed to operate at high pressure due to the predominance of C_3 hydrocarbons present in the feed. The principal reason for using four reactors is a function of the large capacity of the unit. A single reactor, or even two, would have been impractical from the standpoint of the fabrication and erection problems involved. For simplicity, however, only two of the four reactors have been shown in the flow sheet.

Moreover, dividing the catalyst requirement into numerous small beds, rather than relatively fewer but correspondingly larger beds, makes for the optimum in product quality and operating flexibility. This is because better uniformity in reaction temperatures can be more easily maintained in the smaller beds of a multiple reactor system in parallel, while there is greater assurance of securing intimate contact with the catalyst at all times. Also, in the event of a substantial reduction in the volume of available fresh feed, one or several reactors can be by-passed without introducing the problem of maintaining uniform flow through the catalyst beds—a situation sure to be encountered when the flow rate through the large beds of a single reactor is significantly reduced below design limits.

There is another operating convenience inherent in the use of multiple reactors. If only one reactor were used, it is unnecessary to shut the entire unit down for catalyst change when the original charge becomes spent. The reactor charge is reduced to approximately three-fourths of the design flow rate and one of the reactors is taken off the line for catalyst replacement. When this work is completed, the reactor is purged and returned to service in the usual manner. The remaining reactors are similarly taken out of service in succession, or as necessary, until a complete re-charge has been effected.

requires four reactors in parallel"

Another unusual design feature of this unit is the employment of an effluent separator following the reactor section. Here, a substantial portion of the propane present in the reactor feed as a diluent for the olefins present in the fresh feed, and unaffected by the reaction, may be flashed from the reactor effluent. The flash vapors are split into two streams. The first is condensed to a liquid and returned to the process from the condensate receiver: either as recycle to the reactor section by admixture with incoming fresh feed, or as interbed quench to the reactors for reaction temperature control. The balance of the flashed vapors not needed in the process is sent to the fractionation system. The liquid portion of the effluent also is charged separately to this fractionation system.

The usual UOP design omits the effluent separator, and derives the substantially paraffinic recycle and quench streams from a depropanizer in the fractionation section which is normally a part of the design. Flashing the reactor effluent, as in the design for the Tidewater installation, makes possible a significant reduction in the size of the depropanizer otherwise required, and also in the piping necessary.

Fresh charge to polymerization is the overhead stream from a depropanizer in the refinery gas plant. Although small amounts of ethane and ethylene are expected to be present, for the purpose of design the charge was considered to consist of approximately 60 vol-% C_3's of which 52% is propylene, and about 40% C_4's, of which 45% also is olefinic. The design conversion is a minimum of 90% of the total unsaturates present in the fresh feed. Feed and products are shown in Table 1.

CAT POLY UNIT's reactors are designed to operate at high pressures

The design product will be about 5140 b/sd of "true polymer" (debutanized reactor effluent) having a Research octane number of approximately 96, unleaded, and a Reid vapor pressure of 2 psi. It should be pointed out that, in practice, a 2# RVP polymer gasoline seldom is produced in most refineries because of operating considerations. This likely will be the case at Delaware City, too. Normally, the vapor pressure of the as-produced polymer gasoline is adjusted from time to time in conformity with the particular blending requirements which exist and, therefore, as-produced polymer gasoline usually exceeds in volume the design quantity of true polymer.

As an example of the type of product which may be made with the polymerization unit designed for Tidewater, the characteristics of a typical polymer gasoline are presented in Table 2. This material has an unleaded Research octane rating of 97 and, with 3 ml of TEL per gallon, will test approximately 100 octane. When more C_4's are present in the feed, the resulting polymer gasoline would be expected to have somewhat higher distillation temperatures in the higher boiling portion of the product. Of course, inclusion of additional butane in the product of Table 1 would increase the vapor pressure and substantially decrease the boiling points below those shown for the lighter portion of the example given.

Table 1—Feed and products, catalytic polymerization unit

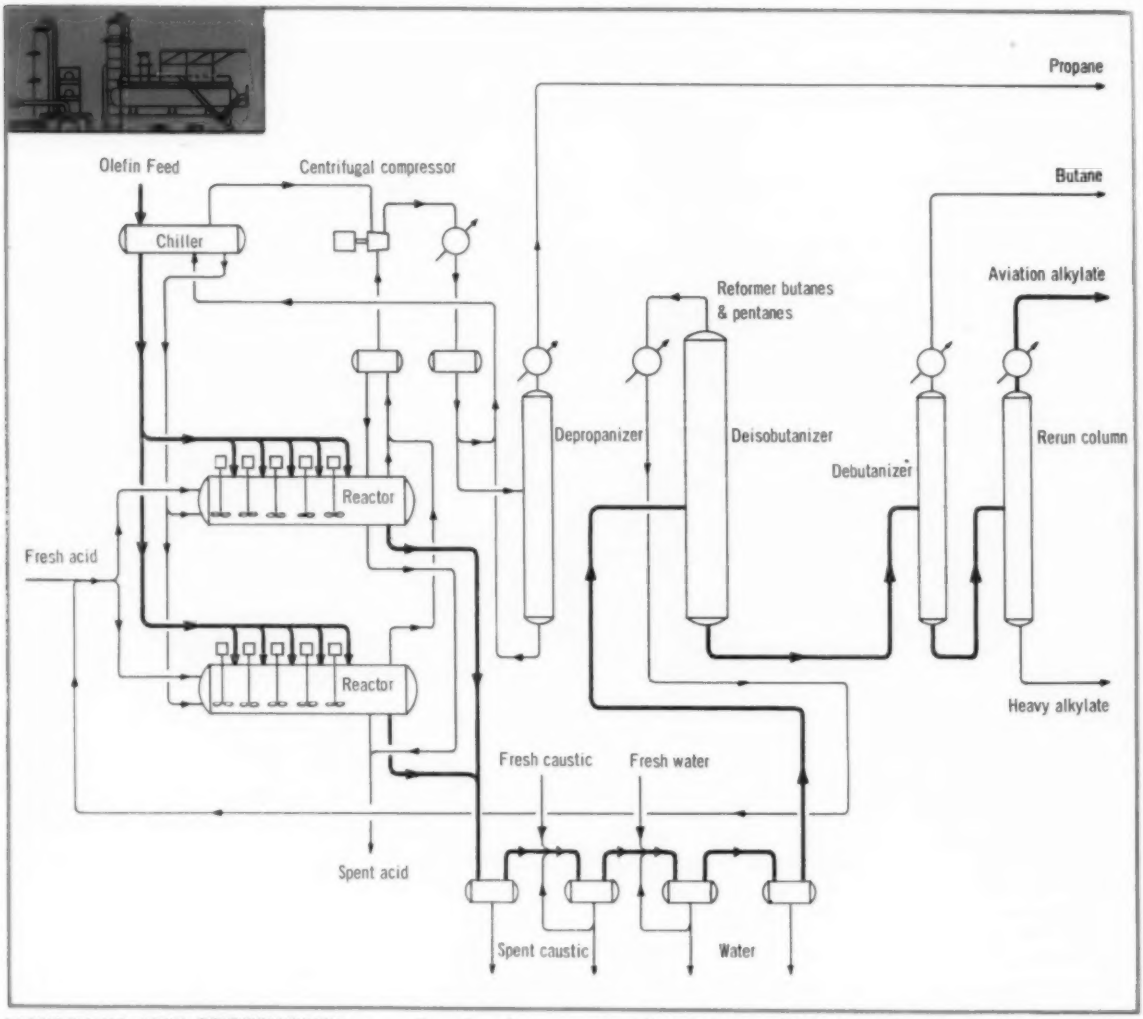
	b/sd	Vol-%	
Feed:			
Ethylene	17	0.1	
Ethane	195	1.2	
Propylene	4,700	29.6	57.1
Propane	4,350	27.5	
Butylenes	3,000	18.9	
Isobutane	2,930	18.5	41.6
Butane	660	4.2	
	15,852	100.0	
		Vol-% on feed	
Products:			
Propone	4,824	30.4	
Butane	3,888	24.6	
Polymer gasoline*	5,136	32.4	
	13,848	87.4	

*Based on 90% conversion of C_3-C_4 olefins.

Table 2—Typical polymer gasoline from predominantly C_3 charge

Gravity, °API	62.4
ASTM distillation, °F	
IBP	144
10%	204
30%	244
50%	266
70%	284
90%	390
EP	402
Sulfur, wt-%	Nil
Reid Vapor Pressure, psi	4.0
Research octane rating:	
Clear	97
3 ml TEL/gal	100

"... effluent



AMYLENES AND PROPYLENES, as well as butylenes can be alkylated here. Sulfuric acid consumption is very low

ALKYLATION UNIT

By S. R. STILES
M. W. Kellogg Co.

THE alkylation plant at Tidewater's Delaware Refinery processes an olefin-rich stream from the Orthoflow catalytic cracker and the gas plant. The unit alkylates isobutane with these olefins in the presence of sulfuric acid catalyst. The product alkylate is used as a blending stock for aviation and motor gasolines.

The principal olefins processed are butylenes. However, an appreciable quantity of amylenes and propylenes can be alkylated along with the butylenes to produce between 5,000 and 6,000 b/sd of alkylate depending on the availability of isobutane. The product has an aviation performance number of 157-160 (rich-mixture F-4 plus 4.6 cc TEL/gal) at the design capacity of 5000 b/sd. The sulfuric acid consumption is exceptionally low—less than 0.3 lb/gal of total alkylate produced. At 50% of design capacity the unit will produce alkylate of 167 F-4 PN from a mixed butylene-amylene feed.

The plant utilizes two Kellogg Model C Cascade reactors. Auto refrigeration removes the heat of reaction and maintains the reaction temperature at approximately 40°F. Each reactor is a horizontal vessel containing five reaction zones, an acid settling zone, a surge zone for the hydrocarbon effluent and also a vapor disengaging zone.

Fouling of equipment for processing the reactor effluent is minimized by recent improvements, specifically by an improved treating system which effectively removes troublesome con-

treating system eliminates inhibitors"

taminants. This has also eliminated the need for inhibitors, normally used in other units to prevent corrosion. In addition, an extremely sensitive laboratory technique for determining the presence of fouling contaminants in concentrations of less than 1.0 ppm is used for operational control.

Isobutane availability in the Delaware refinery governs the quantity and type of olefin feed brought to the plant. Olefin feed, generally deficient in isobutane, is recovered as a single stream from the gas plant and treated with caustic to extract essentially all of the mercaptan sulfur, a prerequisite for low acid consumption.

The treated olefin feed is chilled, partially dried, and charged directly to the reaction compartments of the reactors. Butylenes are preferentially included in the feed with amylenes selected next by adjusting the gas plant operation. Propylene is recovered as cat poly feed and is included in alkylate feed as additional isobutane becomes available. The butane fraction from a reformer is charged to the deisobutanizer tower to recover the requisite additional isobutane. The deisobutanizer overhead, containing both this isobutane and the main reactor-recycle isobutane, is sent to the first reactor zone along with the isobutane recycle stream from the refrigeration system.

The flow arrangement in these Cascade reactors permit the production of high quality alkylate while minimizing the quantity of deisobutanizer overhead recycle. In the forward zones of these reactors, the isobutane is maintained at extremely high levels. The overall process arrangement of Tidewater's Delaware Refinery is extremely versatile and can process a wide range of feeds.

Propane dilution in the Cascade reactor has a deleterious effect on quality of alkylate product. For this reason, the reactors are operated at low pressure to reduce the propane inventory in the reactor. A substantial octane improvement of the alkylate product quality results. Propane is rejected from the refrigerant stream via the depropanizer tower overhead where the propane concentration is the highest in the plant.

The alkylate recovered from the deisobutanizer tower is fractionated in a debutanizer tower and a two-stage rerun tower to recover butane, light alkylate (338°F EP) and heavy alkylate products for gasoline blending purposes. A two-stage rerun tower system is used for operating flexibility and economy. This permits segregation of the light alkylate from the debutanizer into two products for future blending purposes.

REDUCED ESTER CARRYOVER in the alkylation unit reactors cut fouling

Although present refinery plans call for alkylate production rates of approximately 5000 b/sd, future expansion in excess of 9000 b/sd is possible by the addition of exchangers and pumps.

Items of equipment such as key exchangers and pumps subject to fouling are installed with block-valves and bypasses so they may be taken out of service while the rest of the unit continues to operate. The operation of the improved effluent treating system reduces the frequency of exchanger cleaning and eliminates the need for inhibitors found in other alkylation units.

A combination control house for both the alkylation and catalytic polymerization units contains modern automatic data recording devices for operating each of the two units.

Economical use of steam is obtained in the alkylation unit by combining the steam requirements of the major turbines with that of the fractionation system. The turbine exhausts to a 40-psig steam system which is used to operate a portion of the fractionation system.

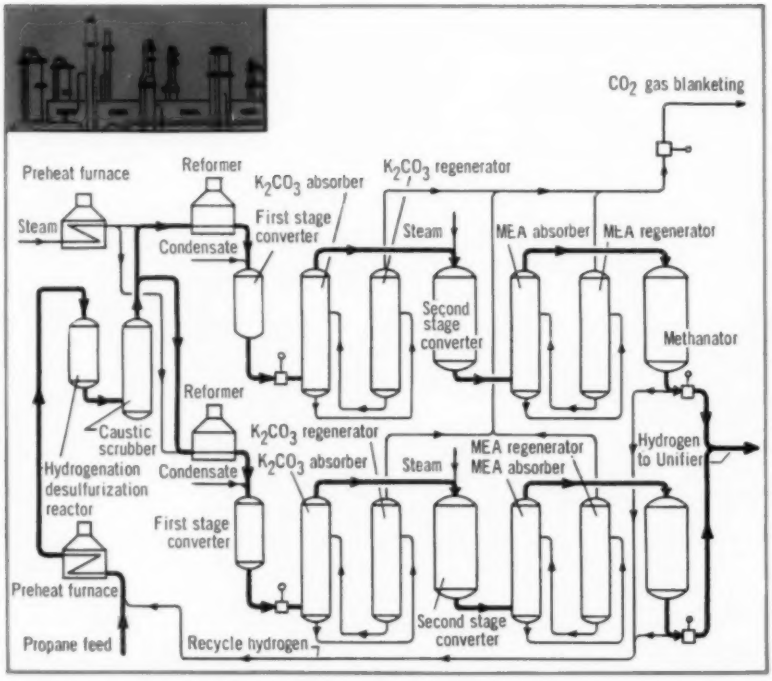
Flexibility is obtained by combining electric motor and steam turbine drives for alternate pumps on various services.

A three-stage centrifugal compressor with a direct turbine drive compresses the propane and isobutane for refrigeration. This turbine delivers a maximum 3,100 hp with steam at 600 psig condensing to a vacuum.

The process engineering and design of the alkylation unit were by M. W. Kellogg Co., procurement and construction by C. F. Braun & Co.

TIDEWATER PROCESSES

"... plant produces



HYDROGEN PLANT FEEDSTOCK is a refinery propane stream

HYDROGEN PLANT

By J. V. CLASS, C. F. Braun & Co. and NORMAN C. UPDEGRAFF Girdler Co., Gas Processes Division

LARGELY because of the high sulfur content of the crude oil which the Delaware refinery is designed to process, there is a deficiency in the amount of hydrogen produced as a byproduct of catalytic reforming in relation to the amount required for treatment of products. For one of the crude oil blends used as a basis for the refinery design, the hydrogen deficiency amounts to 30,000,000 SCFD. This quantity established the design capacity for the hydrogen plant.

This unit, one of the largest of its kind, is further evidence of Tidewater's overall plan for the production of highest quality petroleum products from high-sulfur, heavy crudes.

The refinery uses hydrogen treatment to upgrade several refinery products and intermediate fractions. The nature of the improvement and the amount of hydrogen required, depend upon the particular product. The improvement can be lower sulfur content, greater stability, better color, better odor, or a combination of these.

Several important factors, in addition to the large capacity, dictated the hydrogen plant design. First, the number of products requiring hydrogen treatment set the need for a high service factor. Second, the relatively high value of manufactured hydrogen required a flexibility to meet widely varying hydrogen demands. And third, efforts to minimize utility requirements resulted in the selection of a process employing high-pressure catalytic reforming, and carbon-dioxide removal by hot-potassium-carbonate scrubbing.

After analysis of these requirements, the anticipated refinery turnaround schedules, and the various cost factors, the engineers concluded that the hydrogen producing capacity should be installed in two essentially parallel units, each with 15,000,000 SCFD capacity, with each designed to operate efficiently when producing at rates as low as one-fifth of design.

The feed pretreating and reforming sections of the hydrogen plant were engineered and supplied by The Girdler Co. which also supplied all the catalysts used in hydrogen production and purification. C. F. Braun & Co. engineered the hydrogen-purification section, and designed and erected the entire hydrogen unit.

Feedstock pretreatment: Hydrogen can be produced by reforming hydrocarbons, with natural gas, refinery fuel gas and ethane, propane or butane streams being commonly used. But the Delaware Refinery has neither natural gas nor an ethane stream available. The refinery fuel gas is not acceptable because of its nitrogen content. For these reasons, a refinery propane stream provides the hydrogen plant feed.

Due to the presence of organic sulfur compounds and unsaturated hydrocarbons in the refinery propane stream, there was some question as to whether the steam-hydrocarbon reaction could be carried out under design conditions without carbon formation and deposition on the reforming catalyst. Accordingly, The Girdler Co. performed tests at its pilot plant in Louisville with a feedstock simulating the refinery propane to be used in the commercial unit.

It was found when operating the reformer furnace under 150 psig pressure, as contemplated in the plant, that the carbon formed was excessive and would soon plug up the catalyst tubes. As a result it was decided to pretreat the gas stream by catalytic conversion and desulfurization.

Referring to the flowsheet, recycle hydrogen is added to the vaporized propane stream and the combined stream heated to the reaction temperature in a furnace. The heated gas stream is then passed over a catalyst in the reactor. The catalyst used in this reactor is Girdler G-39, a material particularly suited to organic sulfur conversion.

Hot gas coming from the reactor is cooled by heat exchange with gas from further downstream and finally with water to about 100°F. The cooled gas then enters the caustic treating tower for the removal of hydrogen sulfide. This tower is a bubble tray tower divided into two sections. A so-

95 mol percent pure hydrogen"

lution of sodium hydroxide is recycled through the bottom section for removal of the sulfur compounds. The top section of the tower is a water wash, using condensate for removing any entrained caustic solution from the gas stream. The gas from the caustic treater is heated up again by exchange with the gas from the hydrogenation desulfurization reactor before going to the reformer furnaces. Prior to entering the furnace tubes, the feedstock is mixed with superheated steam in the quantity needed for the steam hydrocarbon reaction.

Reformer furnaces: Starting with the reformer furnaces the plant is divided into two parallel trains. Each furnace is divided into a number of combustion chambers containing vertical tubes. The tubes are approximately 30 ft long, made of alloy steel, and will operate at 125 to 150 psig and 1600 to 1700°F. The tubes contain Girdler G-29 nickel-base catalyst which promotes the reforming reaction to a high degree, giving near theoretical approaches to equilibrium.

The following reactions take place in the furnace tubes:

(1) $C_nH_{2n+2} + nH_2O = nCO + (2n + 1)H_2$

(2) $C_nH_{2n+2} + 2nH_2O = nCO_2 + (3n + 1)H_2$

(3) $CO + H_2O = CO_2 + H_2$

The furnaces are designed for gas firing to supply the heat needed for the above reactions. The flue gases emerge from the furnace and pass through a waste heat boiler to produce 175 psig steam.

Hydrogen purification: The gases leaving the reformers at 1400-1500°F, are first cooled by injecting condensate, then flow to the first-stage of shift conversion. Here, the reaction of carbon monoxide with steam forms carbon dioxide and hydrogen as follows:

$$CO + H_2O = CO_2 + H_2$$

The converters use Girdler G-3 catalyst, a chromium-promoted iron oxide material, which converts most of the CO present according to the above reaction. This stage of conversion is carried out at approximately 700 to 800°F, achieving a close approach to equilibrium.

Following the first stage of conversion, the gas is compressed to 300 psig and most of the carbon dioxide in the gas mixture is removed by scrubbing with hot potassium carbonate solution. The gases are then mixed with steam and sent to second-stage of shift conversion to form additional hydrogen by converting carbon monoxide to carbon dioxide thus reducing the carbon monoxide content of the gases to a very low value. The carbon dioxide formed in the second-stage of shift conversion is removed by scrubbing with an aqueous monoethanolamine solution.

Following the amine scrubbing, the residual carbon oxides are reacted with hydrogen to form methane according to the following reactions:

$$CO + 3\ H_2 = CH_4 + H_2O$$

$$CO_2 + 4\ H_2 = CH_4 + 2H_2O$$

Girdler G-12 nickel catalyst is used for these reactions. A purified hydrogen essentially free of CO and CO_2 is obtained as required by the process specifications. The methanation reaction in this instance is carried out at approximately 500 to 600°F.

After compression to approximately 800 psig, the hydrogen product supplies the need of the hydrodesulfurizers.

Products: The plant manufactures hydrogen of 95 mol percent purity. The remaining components include methane and traces of carbon monoxide and carbon dioxide. In addition to hydrogen, the plant will produce carbon dioxide, part of which will be used for gas-blanketing storage tanks throughout the refinery.

Feedstock and utility requirements for the production of 30,000,000 SCFD of finished hydrogen are approximately as shown in Table 1.

Special materials of construction are used in three general locations throughout the hydrogen plant. The first of these is for equipment subjected to attack by hydrogen at elevated temperatures and high partial pressures. The second is for equipment subject to corrosion by moist carbon dioxide. And the third is for tubeside parts of coolers and condensers in contact with cooling water.

A steel alloy containing chromium and molybdenum is most generally used in the first of the above locations. However, because of the high temperatures encountered, the effluent piping from the reformers is fabricated of Incoloy. Corrosion by moist carbon dioxide has been minimized in critical locations by the use of aluminum and in some instances, Monel. For the most part, the tubeside parts of coolers and condensers follow the set pattern used in cooling water service throughout the refinery.

Acknowledgement: The authors wish to thank their respective employers, The Girdler Co. and C. F. Braun and Co. as well as Tidewater Oil Co. for permission to publish this article.

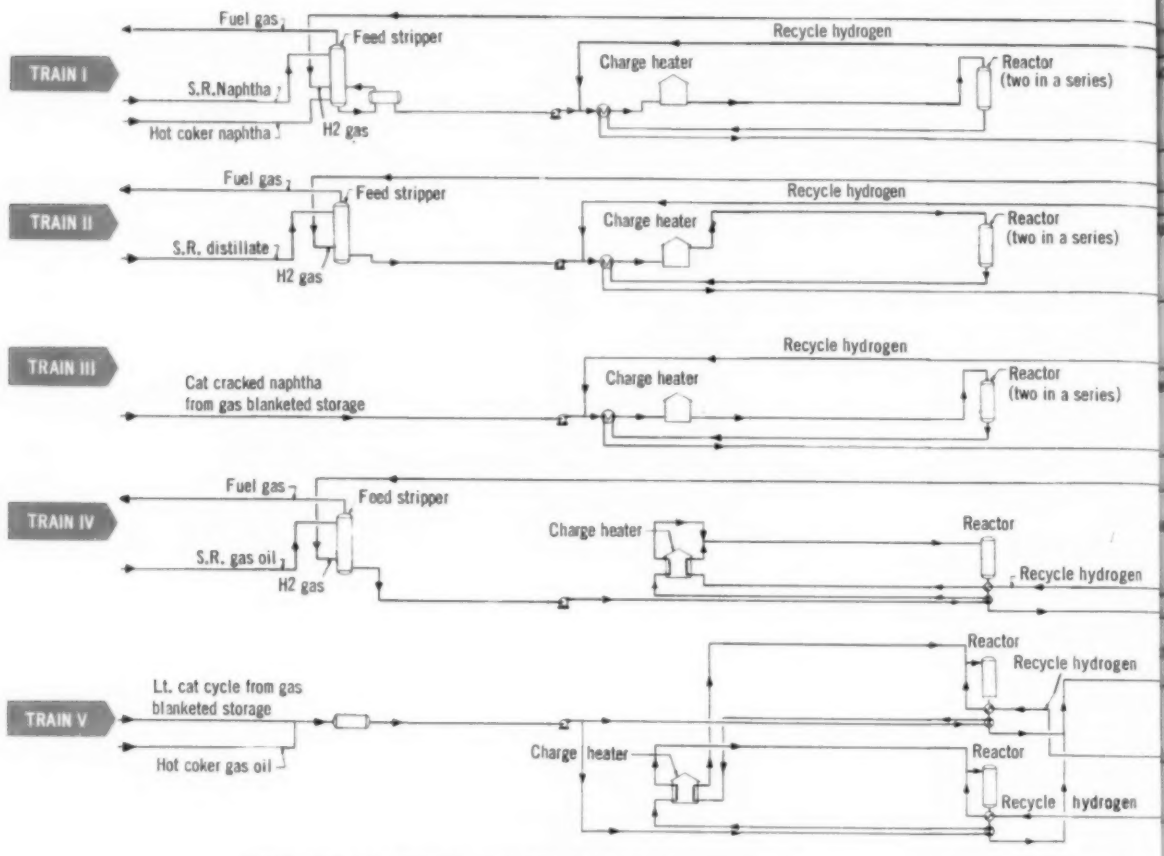
THREE COLUMNS (foreground) and a smaller vessel comprise the hydrogen train, with a similar set-up beyond the compressor house

Table 1—Feedstock and utility requirements

Refinery propane, M gal/day	100
Steam produced, MM lb/day	2.5
Steam used, MM lb/day	5.6
Fuel gas used, MM Btu/day	7000
Cooling water circ. rate, MM gal/day	30
Electricity, KW	4700

TIDEWATER PROCESSES

". . . all five trains



FIVE SEPARATE TRAINS ON ONE PLOT comprise Tidewater's hydrogen processing unit

DESULFURIZING UNIT

By D. P. THORNTON, Jr.
Universal Oil Products Co.

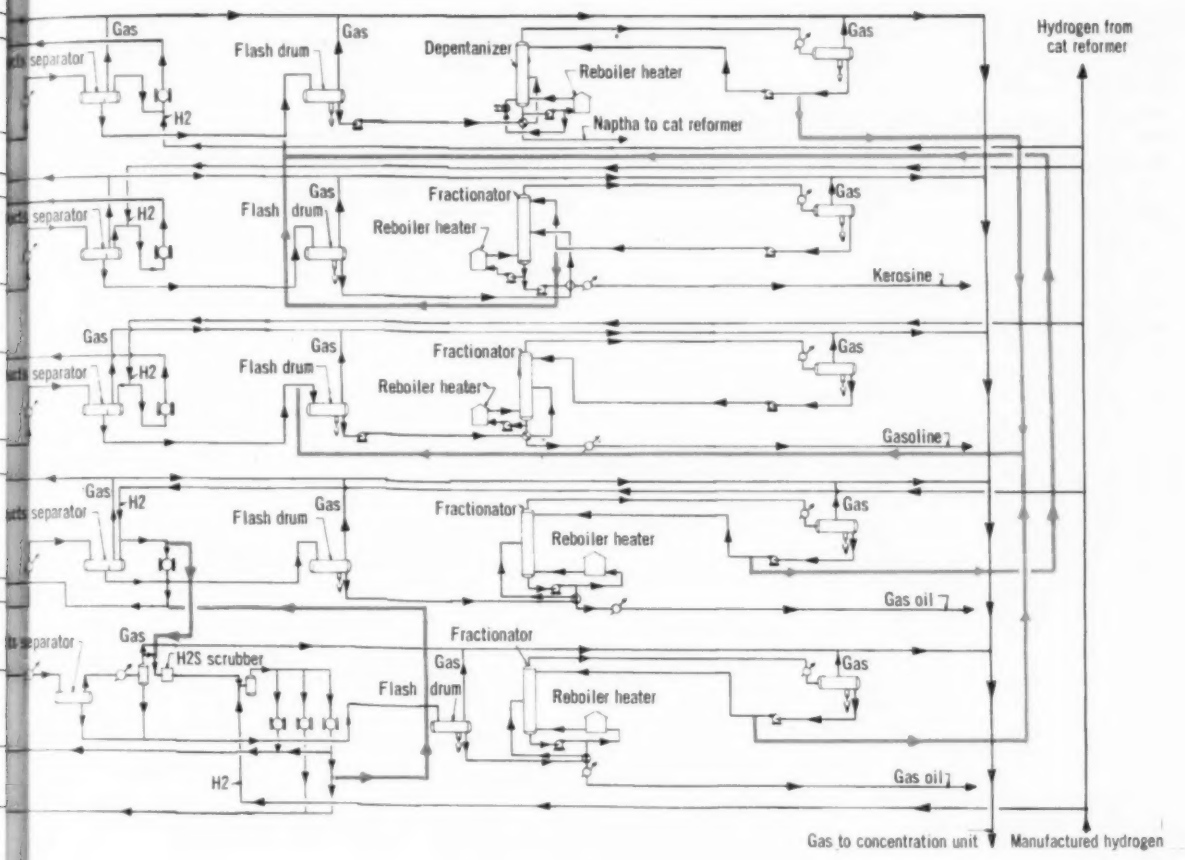
HYDROGEN processing facilities (Unifining) installed in the Tidewater Delaware refinery constitute the largest and most complex ever designed. The unit is capable of processing a total of 88,000 b/sd of various refinery streams. The throughput of some of these streams also exceeds the design capacity of any other single Unifining unit ever built.

Designed by Universal Oil Products Co. and engineered by C. F. Braun & Co. for Tidewater, the installation comprises five separate Unifining "trains" on a single plot, all centrally controlled. These individual trains, each a self-contained Unifining unit in its own right, range in charge capacity from 30,000 down to 9,500 b/sd. They are tied together for convenience by a common hydrogen supply header which draws hydrogen from two independent sources. In some cases portions of the products from the fractionation facilities of one train are commingled with the products from similar facilities of one or more of the other trains. Common headers conveying high and low pressure vapors to the gas concentration plant also are employed. In addition, two trains make use of a common hydrogen sulfide scrubber as well as some compressor capacity. Each train, however, will operate independently.

Hydrogen consumption will be such, when all trains are in operation, that hydrogen production from this refinery's catalytic reforming unit alone is inadequate to supply the demand. Hence, separate hydrogen generating facilities have been provided by Tidewater to supplement the by-product hydrogen production from reforming.

The installation also is unique from a processing standpoint in the extreme degree of flexibility designed into each of the five trains. In every case there is both a "normal" and an "alternate" design feed. The feed composition may be varied within wide limits from the design composition, in practice. Moreover, wide latitude is permissible in the amount of sulfur in the charge which can be handled. Also, three trains can be used for essentially complete saturation of highly olefinic feed stocks in addition to the removal of sulfur and other

operate from a single control room"



impurities. In short, the hydrogen treating (Unifining) installation has been arranged to process virtually every available stream in the Tidewater refinery which can be benefited by hydrogen processing.

It is interesting to note that the exact composition of the various feed stocks, and the sulfur content which might be encountered in operation, was not known at the time the Unifining unit was designed. Hence, provision was made in every train to handle the highest sulfur concentration which could be reasonably anticipated for the future. Thus, the sulfur content of the various feeds and the residual remaining after processing, shown later, should not be considered as limiting from the process standpoint. The installation, therefore, provides the maximum in flexibility in handling available crude oils.

The largest design charge throughput, whether for "normal" or the "alternate" feed, was the controlling factor in determining the size of the individual equipment items for each train. Train I, for example, is designed to process 17,900 b/sd of a blend containing 62% straight-run naphtha and 38% coker gasoline in "normal" operation. In "alternate" feed operation, however, it will process 30,000 b/sd of a blend containing 89% straight-run and 11% coker gasoline. Sizing of pumps, vessels and their internals, and lines was therefore predicated upon the largest anticipated flow.

The design charge stocks, throughput rates and resulting products for the five trains in "normal" operation are shown in Table 1. "Alternate" feeds and products are shown in Table 2. It will be noted that, with the exception of the product from Train V, the sulfur and nitrogen contents of the products are substantially the same in either operation.

The flow sheet, although greatly simplified to meet publication space requirements, illustrates the wide variety of refinery streams processed and the flexibility of the hydrogen treating installation. The actual arrangement of the various components in the commercial unit closely follows the flow sheet arrangement in plot plan. All are operated from a single control room.

Among the several omissions from actual flow is that any water present in the system and which may be drained from the various drums is indicated as being dumped to the sewer whereas, in practice, all water draws tie into a common header which conducts the foul water to specially-designed off-site treating and disposal facilities.

Also, the hydrogen generating facilities, intended to supplement reformer by-product hydrogen, have been omitted as they are not an in-

tegral part of the Unifining process design, although physically located adjacent to these hydrogen treating facilities. To further simplify the flow sheet, spare auxiliaries likewise have been omitted. The individual trains do not require these spares under design conditions although, in several instances, common spares have been provided for adjacent trains.

Train I, as shown in the flow diagram, charges a blend of straight-run and coker naphthas. The straight-run naphtha is charged to the feed stripper where a counter current stream of hydrogen denudes it of dissolved air and other volatile impurities remaining after pretreatment elsewhere in the refinery. Coker naphtha is admitted to the bottom of this column to blend it with the stripped straight-run material as reactor charge.

Reactor charge is mixed with hydrogen, exchanges heat against reactor effluent, is further heated to reaction temperature and contacts the Hydrobon* (cobalt molybdenum) catalyst in two reactors of special design. These are connected in series. This arrangement, rather than a single, correspondingly large reactor, has been employed for convenience in the fabrication of the vessels themselves, and for operational and maintenance flexibility.

Reactor effluent is cooled as shown before entering a high pressure separator where hydrogen-rich vapor is flashed off. This vapor is in part returned to process, along with make-up hydrogen, via a compressor. The balance enters a header to the gas concentration unit where hydrogen sulfide, ammonia and other impurities are removed and light hydrocarbons are recovered. Make-up hydrogen is normally supplied wholly from reformer net hydrogen production.

The separator liquid is reduced to a still lower pressure in a flash drum, the vapors from which are sent to the gas recovery plant for further processing. The liquid in this drum is allowed to settle, any water being drawn from a boot for disposal. The hydrocarbon product is pumped to a depentanizer.

The depentanizer produces as a bottom product the principal naphtha feed to catalytic reforming. The overhead product joins the fractionator overhead liquid from Train V, the mixture then being pumped into the flash drum of Train III, flashed and the liquid subsequently fractionated.

Table 1—Properties of fresh charge stocks and products—Unifining unit

Fresh stock charge to each train:							
Train number	**I**		**II**	**III**	**IV**	**V**	
Composition	**Blend of Straight-run naphtha**	**Coker gasoline**	**Virgin distillate**	**Heavy catalytic-cracked naphtha**	**Light virgin gas oil**	**Blend of Coker gas oil**	**Catalytic gas oil**
Vol—% in blend	62	38	100	100	100	20	80
ASTM distillation:							
IBP	200	100	390	300	500	400	440
10%	240	165	420	330	530	475	485
50%	285	265	465	360	565	530	540
90%	335	370	500	400	600	600	600
End point	370	400	525	450	625	640	650
Gravity, °API	52	53.3	39.5	33	32.5	27.5	18
Bromine number	5	120	—	35	—	73	18
Sulfur, wt-%	0.20	1.00	0.52	1.5	1.6	4.0	3.90
Basic nitrogen, ppm.	5	38	—	185	—	—	—
Design charge rate, b/sd	17,900		9,300	9,500	13,500	25,000	
Butane-free product of Unifining:							
Yield, b/sd (design)	17,485		9,005	9,225	13,055	24,490	
Sulfur, wt-%	0.02		0.10	0.10	0.10	0.50	
Basic nitrogen, ppm.	1.		—	5	—	—	

This depentanizer also receives as a portion of its feed the overhead product from the fractionator in Train IV. This is commingled with the separator effluent of Train I at the flash drum mentioned earlier.

The depentanizer of Train I is unusual in that it has both a fired reboiler and an exchanger-type reboiler. Although this detail flow is omitted in the flow sheet, the exchanger-type reboiler exchanges heat with the reactor effluent and helps cool this stream when the unit is charging the "normal" feed, for then there is more heat available, due to the greater olefin content of the feed and consequently greater heat evolution in the reactor. The fired reboiler is then on low duty. When the unit is charging the "alternate" feed, on the other hand, there is a deficiency of heat for operating the depentanizer due to the fact that throughput to the train is much lower in quantity and has a considerably lower olefin content. Then, the fired reboiler is used to supplement the heat input from the exchanger reboiler.

Train II feed is a 390-525°F. virgin distillate, which merely varies quantity-wise insofar as "normal" or "alternate" operations are concerned. The processing arrangements are almost identical with those of Train I. A fractionator completes the processing facilities, the bottom product from which is kerosine. The overhead product, essentially a heavy gasoline fraction, is sent to the low pressure flash drum of Train I and eventually appears as part of the charge to catalytic reforming.

Train III charges caustic-washed heavy catalytic naphtha from gas-blanketed storage directly to the feed-to-product heat exchanger; there is no feed stripper. Standard Unifining processing practice is followed here, also, the liquid being separated from the vapors in high and low pressure separators, and fractionated. The fractionator overhead product in excess of reflux requirements goes, as vapor, to gas concentration; the bottom product is a heavy gasoline. The hydrogen supply to Train III is derived for the most part from catalytic reforming supplemented by generated hydrogen.

The primary purpose in Unifining catalytically cracked gasoline is for desulfurization and removal of basic nitrogen compounds. The extent of desulfurization required for purifying the product, however, necessitates using sufficiently severe processing conditions so that essentially complete hydrogenation of olefins also occurs. The sulfur content of the product must be brought down to 0.1 wt-% from the design contents of 1.5 and 0.7 wt-%, respectively, of the "normal" and "alternate" feeds. Complete hydrogenation is readily obtainable by suitable adjustment in processing severity.

Table 2—Properties of alternate fresh charge stocks and products—Unifining unit

Alternate fresh charge to each train:						
Train number	I		II	III	IV	V
Composition	Blend of Straight-run naphtha	Coker gasoline	Virgin distillate	Heavy catalytic-cracked naphtha	Light virgin gas oil	Catalytic gas oil
Vol—% in blend	89	11	100	100	100	100
ASTM distillation:						
IBP	200	100	390	300	500	440
10%	240	165	420	330	530	485
50%	285	265	465	360	565	540
90%	335	370	500	400	600	600
End point	370	400	525	450	625	650
Gravity, °API	52	52.3	39	33	32	22
Bromine number	4	120	—	—	—	18
Sulfur, wt-%	0.23	0.70	0.54	0.70	1.0	3.15
Basic nitrogen, ppm.	5	38	—	185	—	—
Design charge rate, b/sd	30,000		10,000	7,700	11,600	16,400
Butane-free product of Unifining:						
Yield, b/sd (design)	29,160		9,680	7,425	11,185	16,145
Sulfur, wt-%	0.02		0.10	0.10	0.10	0.40
Basic nitrogen, ppm.	1		—	—	—	—

This product will have lost some of its original octane quality on a clear basis as a consequence of saturating most of the olefins it originally contained, but the leaded octane is lowered only slightly. However, its high sulfur content would have precluded its immediate use in blending gasoline and extensive treating would have been necessary in any event. Since, for future higher octane ratings of refinery gasoline, the product might need upgrading from the standpoint of octane number, it is understood that the operator may elect to use a portion of it as a supplementary feed to catalytic reforming.

Train IV desulfurizes light virgin gas oil which is subsequently blended as No. 2 burning oil, or may be sold as diesel fuel if the cetane number is satisfactory. This train again is a standard Unifining unit, plus a feed stripper and a product fractionator. Since the charge stock will contain from 1.0 to 1.6 wt-% sulfur and the product is required to have not more than 0.10% sulfur, provision has been made for the diversion of part of the recycle hydrogen to a hydrogen sulfide scrubber, located in Train V, and to use a part of that train's hydrogen compressing capacity to return it to the Train IV reactor. This prevents excessive build-up of hydrogen sulfide in the recycle hydrogen to the reactor. Hydrogen supply to this train is for mostly generating facilities.

The overhead liquid product of the fractionator of Train IV joins the feed to fractionation in Train I at the flash drum of the latter, because this gasoline will be low in octane rating and therefore needs catalytic reforming. As previously noted, the products from the fractionators which the liquid from this drum feeds are gasoline to catalytic reforming and vapors to the gas concentration unit.

The bottom product from the fractionator of Train IV is a gas oil. Its sulfur content will not exceed 0.1 wt-%.

Train V charges a blend of coker (4.0 wt-% sulfur) and catalytically cracked light gas oil (3.9 wt-% sulfur) for desulfurization. This results in substantially complete hydrogenation of olefins, also, as in Train III. The alternate charge is a catalytic gas oil containing 3.15 wt-% sulfur, which likewise is essentially saturated during desulfurization. The sulfur content of the "normal" product is reduced to 0.5 wt-%; that of the "alternate" to 0.4 wt-%. Either product is a pure, stable fuel oil of high quality.

The feeds enter a surge drum for blending. A feed stripper is not necessary because the catalytically cracked portion of the charge is received from gas-blanketed storage and the coker oil is received as a hot stream.

Two reactors in parallel are employed in this train because the volume of the charge is large and the stocks are high in sulfur and olefins; hence, hydrogen consumption is large. In normal operation the principal supply is derived from generated hydrogen. The product is a desulfurized and almost totally saturated No. 2 fuel oil.

Most other principal features of this train already have been mentioned in connection with the discussion of preceeding trains; namely, the sharing with Train IV of the hydrogen sulfide scrubber and some recycle hydrogen compressor facilities. The net gasoline produced by the fractionator as overhead product is relatively large in quantity and high in octane rating (100 Research clear from test samples). It is sent to Train III flash drum to be fractionated and is included with treated product from this train.

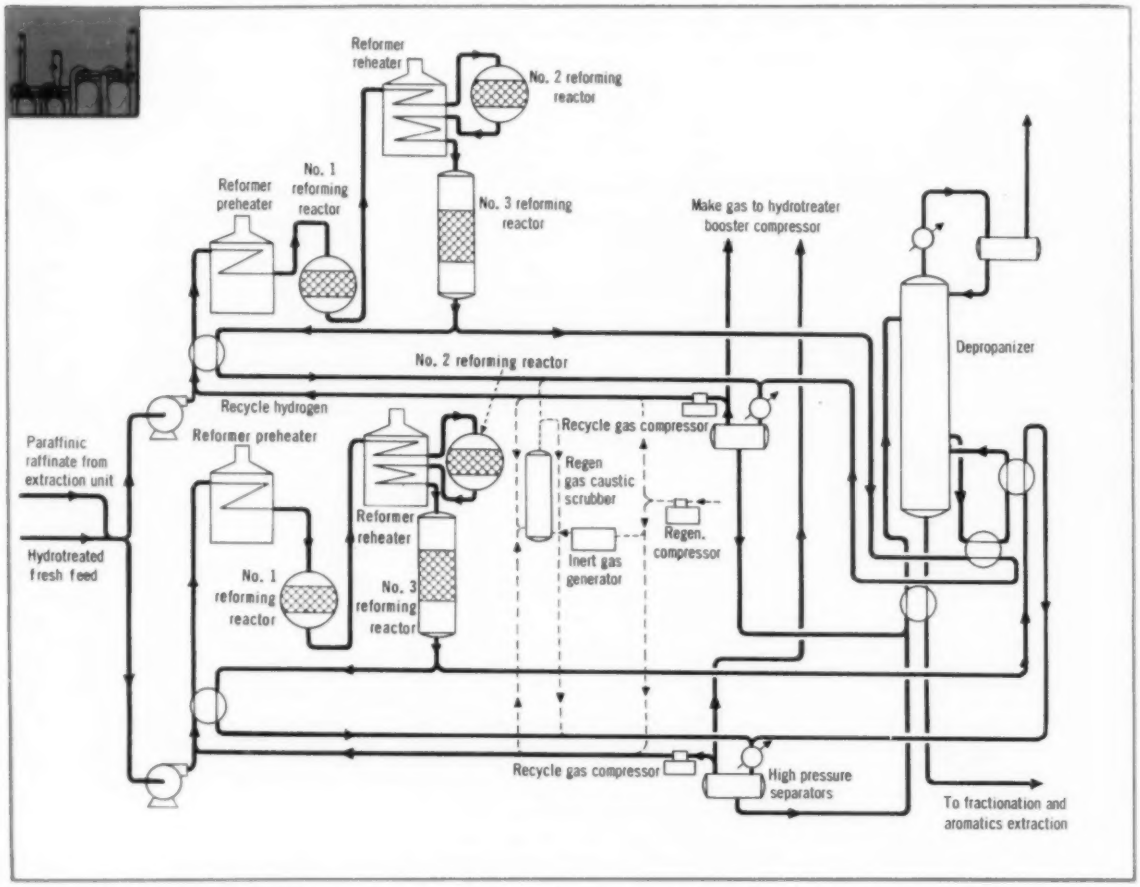
Hydrogen requirements are quite high for this unit in view of the large throughputs, high sulfur content and considerable degree of unsaturation. For this reason, the hydrogen supply is normally 100% manufactured hydrogen of high purity. A hydrogen sulfide scrubber (amine type) has been included to permit maximum utilization of the hydrogen content of the high pressure separator gas. Because adjacent Train IV also is a large hydrogen consumer and likewise treats a high sulfur stock, the H_2S scrubbing facility of Train V was sized to desulfurize a portion of its recycle gas production, too. For convenience, the recycle gas compressor section of Train V supplies a part of the recycle gas to the reactor section of Train IV. The equipment is so arranged that Train V can operate satisfactorily when Train IV is down, and vice versa.

The Unifining installation at Tidewater illustrates vividly the benefits which can be obtained by the hydrogen treating of both olefinic and extremely high sulfur refinery streams, to produce pure products of maximum sales value, and having wide utility when further processing is contemplated. No reasonable expense was slighted in either design or construction when it could be shown that real economic justification existed. While in no sense a "gingerbread plant," the watchwords were optimum product quality, maximum flexibility, and operating economy.

The Unifining process was licensed jointly by Universal Oil Products Co. and Union Oil Co. of Calif.

TIDEWATER PROCESSES

". . . design provides



THIS FLOW DESIGN permits economic operation with a wide variety of feed quality and feed rates

CATALYTIC REFORMER

E. A. WHITE, Jr.
Senior Process Engineer
Houdry Process Corp.

THE 45,200 b/sd twin-train Houdriformer onstream at the Delaware Refinery of Tidewater joins other record-breaking units in this plant as the largest of its type in the world.

Using Houdry's new 3-D platinum-containing reforming catalyst, and coupled with a feed pretreat unit and an aromatics extraction section, the Houdriformer is the heart of a process section responsible for producing the refinery's highest octane blending stock for both aviation and motor gasolines.

Built-in facilities provide in-place catalyst regeneration, with a single regenerating system serving both Houdriformer reactor trains. The twin trains may be operated in combination or singly, in order to assure continuous high octane gasoline production should one train require shutdown for inspection, regeneration or turnaround.

Blending stock of 102-104 F-1 clear octane is obtained at non-regenerative operating severities when the Houdriformate undergoes aromatics extraction in the coupled Udex unit, which recycles paraffinic raffinate to the Houdriformer. This high octane blending stock has been achieved in a single-train operation of the Houdriformer at the moderate conditions shown in Table 1.

At design throughput and with design charge stock, the Houdriformer's yield of debutanized reformate, including recycled paraffinic raffinate, is 81.6 vol-% of charge, at 90 F-1 clear octane. The Houdriformer itself is capable of producing reformates in excess of 95 F-1 clear octane in once-through regenerative operation. However, inasmuch as plans envision only moderate operating severities for some time to come, operation for a year or more without need for catalyst regeneration is expected.

Although the naphtha-upgrading

flexibility at low feed rates"

CAT REFORMER throughput includes 15,200 b/sd of paraffinic recycle

plant was designed for a specific rate and composition of feed stock, the unit is so engineered that economic operation is possible with wide variations in feed quality and in feed rates to produce several qualities of reformate. Flexibility is provided by desulfurization and pretreatment of charge, the twin-train design and the common regeneration service of the Houdriformer, and the aromatics extraction section.

Process Description: The reactor section consists of two parallel trains of fixed-bed downflow reactors, three in each train. Each train has a heater with one preheat and two reheat services, a reactor charge pump, a recycle gas compressor, feed to effluent exchangers, effluent condensers, and an effluent liquid-gas separator. The unit is designed to operate with the separator at 465 psig.

Fresh feed, hydrotreated and stripped in the desulfurizer, is joined by paraffinic raffinate from the aromatics extraction unit, and is charged to the two parallel reactor trains. Flow is conventional, as shown in the accompanying flow diagram on the opposite page.

Flash liquid from the high pressure separators is combined and fractionated in a common stabilization system. In addition to the depropanizer shown in the flow chart, the stabilization system contains a deheptanizer operating on the depropanizer bottoms, and a 70-plate pentane splitter to separate butanes and isopentane from the deheptanizer overhead for alkylation.

The Houdriformer uses reactor effluent as a high temperature heat medium to reboil the depropanizer in the fractionation section. Two reboilers are provided, one for each reactor train.

Depropanizer column loads are kept above 50% of design load to maintain efficient operation. The column is kept loaded within an acceptable range by maintaining the recycle gas stream at design rates, even when operating at reduced naphtha charge rates.

Holding the recycle stream constant provides sufficient heat in the effluent stream for reboiling the column. With only a single reformer train in operation, the depropanizer can always be loaded to about 50% of design.

High pressure flash gas provides a sizeable portion of the hydrogen used in the many hydrogen treating units

Table 1—Charge and yield of the Houdriformer

	Plant data	
Charge stock:	**Fresh feed**	**Total feed**
Gravity, °API	55.3	53.3
ASTM distillation, °F.		
IBP	185	190
10%	224	222
50	281	269
90	333	332
EP	375	388
F-1 clear octane	—	45.7
Paraffins, vol—%	50.0	62.5
Naphthenes, vol—%	38.0	28.0
Aromatics, vol—%	12.0	9.5
Reforming conditions (single train):		
Catalyst		Houdry 3-D
Fresh feed, b/sd		15,260
Raffinate recycle, b/sd		7,490
Total feed, b/sd		22,750
Vol space rate, V/hr/V		3.03
Reaction temp. range, °F.		914
3rd reactor pressure, psig		520
H_2/naphtha mol ratio		10.0
Yields:		
Debut. reformate, vol—% T.F.		84.1
Total butanes, vol—% T.F.		6.3
H.P. make gas, SCF/bbl. T.F.		405
Reformate (depropanized):		
Gravity, °API		57.7
ASTM distillation, °F.		
IBP		97
10%		144
50		244
90		340
EP		402
F-1 clear octane		83.0
F-1 + 3 cc TEL		94.2
RVP, psi		9.2
C_5 & lighter, vol—%		7.5

of the Tidewater refinery. Compressors operating at 800 psig discharge pressure boost the hydrogen-rich gas up to the operating level of these units.

Regeneration Facility: The twin Houdriformer reactor trains share a common single catalyst regeneration system, manually operated, so that one train may remain in operation while the other is offstream. Equipment provided for regeneration consists of an inert-gas generator, regeneration compressor, and caustic scrubber with caustic makeup and circulation facilities.

The recycle hydrogen compressors are used to circulate regeneration gas through the reformer section, while the regeneration compressor supplies air to the inert-gas generator and also provides regeneration air.

When the level of catalyst activity reaches a point at which regeneration is required, a reformer train is taken off stream, depressured, and purged with inert gas. The unit is then pressured to 150-300 psig and circulation of inert gas is begun with the recycle compressor. Slow addition of oxygen keeps regeneration temperatures in the catalyst beds under control. A slip stream of regeneration gas is continuously circulated through a caustic scrubbing and water wash tower to maintain control of the CO_2 concentration of the total regeneration stream.

When temperature patterns in the catalyst beds indicate that coke burnoff is essentially complete, the oxygen content and regeneration gas temperatures are raised to insure complete clean-up. The unit is then depressed, purged, and restored to operation using hydrogen make-gas from the other reactor train.

Regeneration time will vary with the amount of coke to be removed, but may be expected to take 24-48 hrs. from start to finish.

At design throughput, total feed to the Houdriformer will be 30,000 b/sd of desulfurized West Texas, Kuwait, and coker naphthas, plus 15,200 b/sd of paraffinic recycle from the extraction unit. This operation sets all equipment sizes except for the reactor intermediate reheaters, which are designed for a somewhat more naphthenic charge stock.

The Houdriformer's initial startup was made with virgin naphthas from Texas, Louisiana and Venezuelan crudes. The data shown in Table 1 are for an early plant test made on this stock with a single reactor train in operation.

The Houdriformer was originally designed for Houdry Type 3 reforming catalyst. However, interim development and introduction of the new Houdry 3-D catalyst, offering even greater activity and stability, with consequent reduction in severity of operating conditions, permitted initial loading of reactors with the new 3-D material.

One of the important problems in engineering a large-capacity unit is designing for flexibility at low feed rates. This is especially true in a catalytic process in which catalyst contact-time affects yield structure.

Considerations of flexibility and studies of engineering economics, in this instance, dictated a two-train Houdriformer rather than a single massive reactor section. Studies showed that operating savings, principally in compressor power, would pay out the incremental equipment cost in a little over one year. Further, the two-train design permits a 50% reduction in feed rate without changing design operating conditions. Also, by varying reactor temperature to compensate for catalyst contact-time, total unit feed rate may be changed within wide limits.

Materials and Utilities: The size of the Houdriformer can be appreciated by noting the dimensions of some of the major equipment. Each heater has a total design duty of 156 million Btu/hr. Each recycle compressor is 5280 bhp. Each train contains 14 exchanger shells over 40 inches in diameter. Feed and effluent piping in the heater and reactor section is 18-in. I.D. The depropanizer, deheptanizer and pentane splitter are all over 8 ft in diameter.

The first two reactors in each Houdriformer train are spheres, 10 ft 6 in I.D. Since these reactors carry relatively shallow catalyst beds, it was possible to use a spherical design without encountering the problem of unbalanced vapor flow. A saving of approximately 2¼ in. in shell thickness is achieved, compared with cylindrical reactors. The cylindrical reactors are 11 ft 6 in. I.D., 5 1/32-in. shell thickness, with catalyst beds up to 18 ft deep.

Flanges have been almost completely eliminated from piping carrying hydrogen-rich gas, to minimize possibility of leakage. Connections to all exchangers in the feed-effluent stream, the heaters, and the reactors, are welded. Piping to the exchanger tube bundles is flanged for ease of maintenance.

Access to reactors is gained through manheads on the vertical centerlines, while vapor inlet and outlet lines are at an angle of 30° from the vertical. A circular ring distributes the vapor internally so that the catalyst bed is not disturbed.

In general, materials are steel throughout the reformer unit. Piping and equipment in hydrogen service below 450°F. is carbon steel; above 450°F., a 1 chrome ½ moly alloy is used. Reactors, which are externally insulated, are also 1 chrome ½ moly, as are the exchangers. Heater tubes are 2¼ chrome 1 moly. Impellers of the centrifugal recycle gas compressors are of carbon steel; K-monel impellers were found to be unsatisfactory.

In Table 2 will be found utilities for design operation, including the depropanizer but not the deheptanizer or pentane splitter. Steam is generated in the convection sections of the reformer heaters. The recycle compressors are driven by condensing turbines.

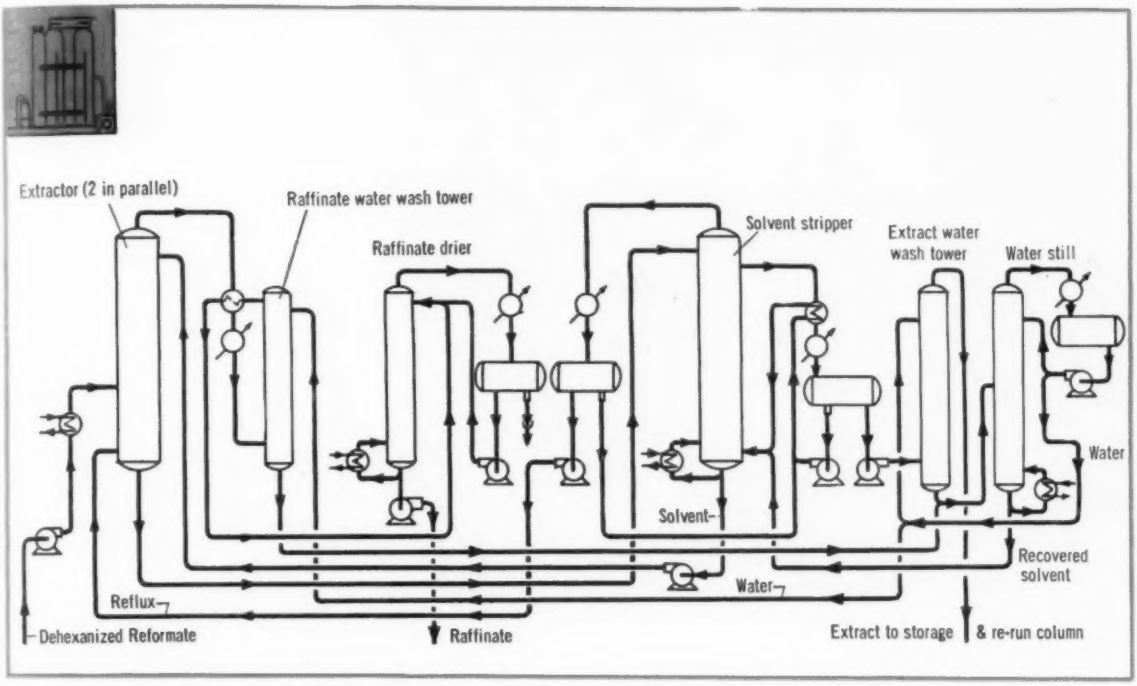
Design and Construction: The Houdriformer is licensed by Houdry Process Corp. Houdry supplied heat and material balances for the reaction and regeneration sections, and the mechanical design of the reactors.

Engineering design of the Houdriformer, process and engineering of the fractionation, procurement of materials and equipment, and construction, were by C. F. Braun & Co. The engineering design included economic selection of the number of reactors, reactor trains, extent of feed-effluent exchange, and the amount of furnace preheat.

Table 2—Design utilities

(With both reactor trains operating)	
Fuel, million Btu/hr	377
Cooling water, gpm:	
37° F. rise	10,200
29° F. rise	6,000
175-psig steam, lb/hr:	
Generated	30,000
Consumed	1,500
600-psig steam, lb/hr	
Consumed	84,000
Power, KW:	
Pumps	640
Lights & instruments	40
Estimated catalyst life (with regeneration), bbl/lb	95

TIDEWATER PROCESSES "single column too big"



SIMPLIFIED FLOW DIAGRAM shows only facilities designed by UOP, and flow for feedstocks of Table below

EXTRACTION UNIT

By D. P. THORNTON, Jr.
Universal Oil Products Co.

TIDEWATER'S Delaware refinery Udex* solvent extraction unit, the largest ever built has been designed to charge 27,000 b/sd of fresh feed, and to produce from it approximately 15,550 b/sd of a concentrate containing between 82 and 88% aromatics. The octane rating of this aromatics-rich product tests in excess of 100 Research, unleaded.

The Udex unit was process designed and licensed by Universal Oil Products Co. with mechanical engineering and construction by C. F. Braun & Co. The UOP design covers only the extraction facilities proper; the necessary feed preparation and extract rerun being engineered and built by Braun.

The purpose of this unit is to make an aromatics-rich concentrate which will be used as blending stocks for high octane aviation gasoline as well as premium and regular grades of motor fuel.

Design charge stock calls for an essentially dehexanized catalytic reformate, prepared elsewhere in the refinery and having the composition shown in Table 1. A part of the feed in actual operation also may include some heavy catalytically cracked naphtha which contains a significant volume of high boiling aromatic compounds. This stock will have been subjected to Unifining and, as a result, will be low in sulfur and in olefins.

It is not intended that high purity aromatics will be produced by this Udex unit. Hence the composition of the solvent, an aqueous glycol solution, is adjusted to also permit retention in the extract of most of the high octane, non-aromatic hydrocarbons present in the feed stock.

The other product of the Udex unit is a predominantly paraffinic raffinate. It contains the low octane hydrocarbons present in the feed as

Table 1—Properties of design fresh stock charge to Udex solvent extraction

Gravity, °API (approx.)	45
Olefins, vol—%	< 1
Aromatics, vol—%	50-60

Composition:	vol—%	vol—% aromatics
C_7	12-18	35-60
C_8	40-50	40-60
C_9	30-35	60-70
C_{10}	7.5 Max.	60-80
Total	100.0	

*Trademark

THIS LARGEST Udex unit ever built charges 27,000 b/sd of fresh feed

well as the small amount of aromatics not separated from them in the extraction step under the design operating conditions. By not requiring complete aromatics recovery in the extract, it was possible to effect reductions in the investment otherwise necessary for the extraction facilities, as well as in operating costs. The aromatics in the raffinate are not "lost" when the raffinate is recycled to catalytic reforming. They reappear in the reformate product of the unit from which the Udex unit feed is derived.

The raffinate is being returned to the reforming units as a part of its feed. Alternatively, some or all of it may be used as jet fuel component.

Local transportation difficulties precluded the use of a single extractor column of the size dictated by standard design considerations. However, the volume of feed was sufficiently large in this case to make practical the use of two extractors connected in parallel. This arrangement has a process advantage for Tidewater of permitting operation of only one tower during periods of reduced throughput of fresh feed.

A simplified flow diagram of the unit is shown on page 125. It is restricted to the facilities designed by Universal and to the feed stock of Table 1. The feed is not cooled en route from the preparation facilities, hence needs only to be brought to the desired temperature for extraction in a feed preheat exchanger. Entering the extractor at about the midpoint, the feed is brought into intimate contact with the descending solvent which enters near the top of the extractor.

Overhead product of the extraction column is paraffinic raffinate which may still contain some of the solvent. This solvent is removed in the raffinate wash tower by contacting countercurrently with water, in which it is very soluble, while the raffinate is almost insoluble. Solvent is recovered subsequently from the wash water as a product from the water still. Dissolved wash water remaining in the raffinate is removed by distillation in the raffinate drier. The overhead water product goes to drain.

The aromatics-rich solvent has a higher specific gravity than either the incoming Udex feed or the raffinate product and is withdrawn from the bottom of the extractor. From this point it goes to the solvent stripper.

The solvent stripper, as its name implies, strips the lower-boiling extract from the higher-boiling solvent. While the design of this column is complex and the details of its operation exacting, its function may best be represented for the purpose of this article as shown in the flow diagram. This indicates that the stripper feed stream is split into a hydrocarbon-water overhead stream, which is primarily used to reflux the extractor, an extract side cut, and a solvent bottom product. In the Tidewater unit the extract is separated from water in a combination settler-accumulator. The settled extract is pumped to the extract wash tower where any remaining solvent is removed. Water-glycol separated in the settler is returned near the bottom of the stripper. By proper control of stripping conditions, the recovered solvent issuing from the bottom of the stripping column is of the optimum composition for immediate return to the solvent extractor columns.

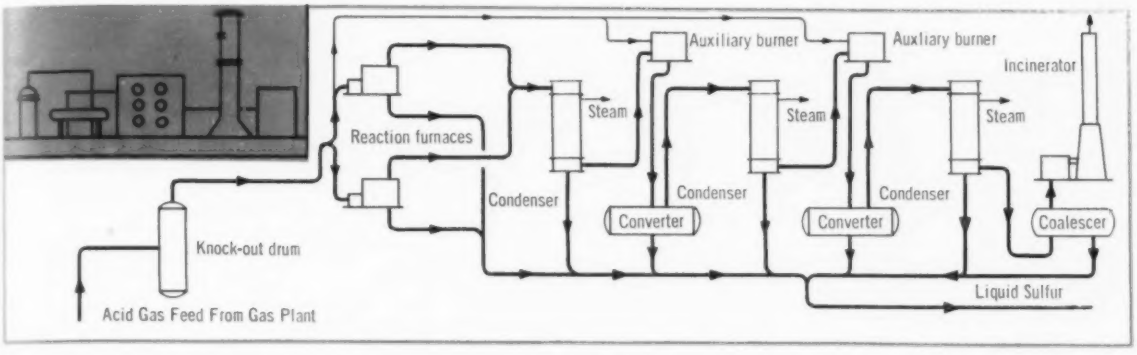
The function of the water still is to provide water for the two wash columns and also to recover the solvent picked up in washing the raffinate and extract streams. Recovered solvent returns to the extraction system via the solvent stripper.

The extract product consists of C_7 through C_{10} aromatics and may contain from 12 to 18 vol-% paraffins and cycloparaffins. The flow sheet indicates that this product is run to storage, as this is the completion of the Udex operation designed by UOP. In the fractionation section designed by Braun, a portion of the extract is subsequently charged to a re-run column. In this distillation, the extract is divided into three streams, the side-cut being stripped and produced as an aviation gasoline component, amounting to about 20% of the charge to the re-run column. The overhead and bottoms products of re-running are combined for use in "regular" and "premium" motor fuels. A portion of the Udex extract is not re-run but is used for motor fuel blending.

The Udex unit is particularly advantageous to the operating scheme envisioned for the Tidewater refinery. It permits the production of an extremely high octane blending material for various uses without the necessity of operating the catalytic reformer at the very high severity—and consequently reduced yields of high octane product—otherwise inescapable. At the same time, the low octane components of the normal catalytic reformate may be recycled for essentially complete conversion into high octane material.

The Udex process was originated by Dow Chemical Co. and developed and engineered by Universal Oil Products Co. It is licensed by UOP for commercial use.

TIDEWATER PROCESSES "adds to steam supply"



TWO FURNACES provide wide operating flexibility in this Parsons-designed giant

SULFUR RECOVERY

By R. E. GOODMAN
Design Supervisor
The Ralph M. Parsons Co.

THE sulfur recovery plant at Tidewater's Delaware refinery is not only important because it is one of the largest ever built; it fills three very important uses in this new refinery:

1. It recovers high-purity elemental sulfur—up to 375 short tons/day.
2. It removes a source of atmospheric pollution.
3. It permits production of highest quality products, by desulfurization.

The entire refinery is designed to handle some of the highest sulfur crude known, ranging from West Texas with 1.5% sulfur to Heavy Wafra with up to 5% sulfur. Many of the sulfur compounds found in these crudes will be converted to hydrogen sulfide during processing, which will be separated in the DEA absorption section of the gas plant. The purpose of the Parsons-designed sulfur plant is to recover the sulfur from the H_2S gas.

Sulfur is recovered from the gas stream by reaction of the hydrogen sulfide with air in a reaction furnace. As the refinery will be called upon to process crude oils of widely varying characteristics, the unit was built with two reaction furnaces, to provide a range of practical operating flexibility greater than that encountered in the normal sulfur plant installation. This also permits annual servicing of the reaction furnaces, one at a time, by carrying the load with the other unit during periods of lower capacity operations.

The process is basically that of controlled partial combustion of the hydrogen sulfide in the acid gas stream with air, in a specifically designed reaction furnace. The resulting sulfur dioxide reacts with the remaining hydrogen sulfide to produce elemental sulfur:

$$2H_2S + 3O_2 \rightarrow 2SO_2 + 2H_2O$$
$$4H_2S + 2SO_2 \rightarrow 6S + 4H_2O$$

Overall reaction is:

$$2H_2S + O_2 \rightarrow 2S + 2H_2O$$

Flow is pictured in the diagram.

The hot combustion gases formed in the external combustion chamber pass through the tubes in each furnace, generating 175-psig steam, with liquid sulfur being formed and recovered. The hot gases from each furnace combine and flow as a single stream through the rest of the unit. The next step is a condenser in which 40-psig steam is generated and additional liquid sulfur is recovered.

After leaving the first condenser, the gases are reheated in an auxiliary burner and passed through a catalytic converter, where additional sulfur is produced. From there the gases flow to a second condenser for further recovery of sulfur and generation of steam.

The gas is again reheated and flows through another converter, then cooled in a third condenser by generating low-pressure steam. Residual gases leaving the final condenser pass through a coalescer. Any residual sulfur compounds in the tail gases are converted to SO_2 in an incinerator before being discharged to the atmosphere through the stack.

The elemental sulfur produced in this recovery process is withdrawn at various points through steam-jacketed lines coming from the reaction furnace, the catalytic converters, condensers, and coalescer. It is collected in an underground pit and is then pumped to two above-ground steel tanks that are equipped with steam coils to keep the sulfur molten. From the storage tanks, the molten sulfur is pumped to insulated tank cars and tank trucks for shipment.

The plant operates at a high rate of conversion. It generates 175-psig and 40-psig steam for its own use and delivers excess steam into the refinery steam system. From 40,000 to 50,000 lb/hr of steam is available for other refinery use with the sulfur plant operating at design rate.

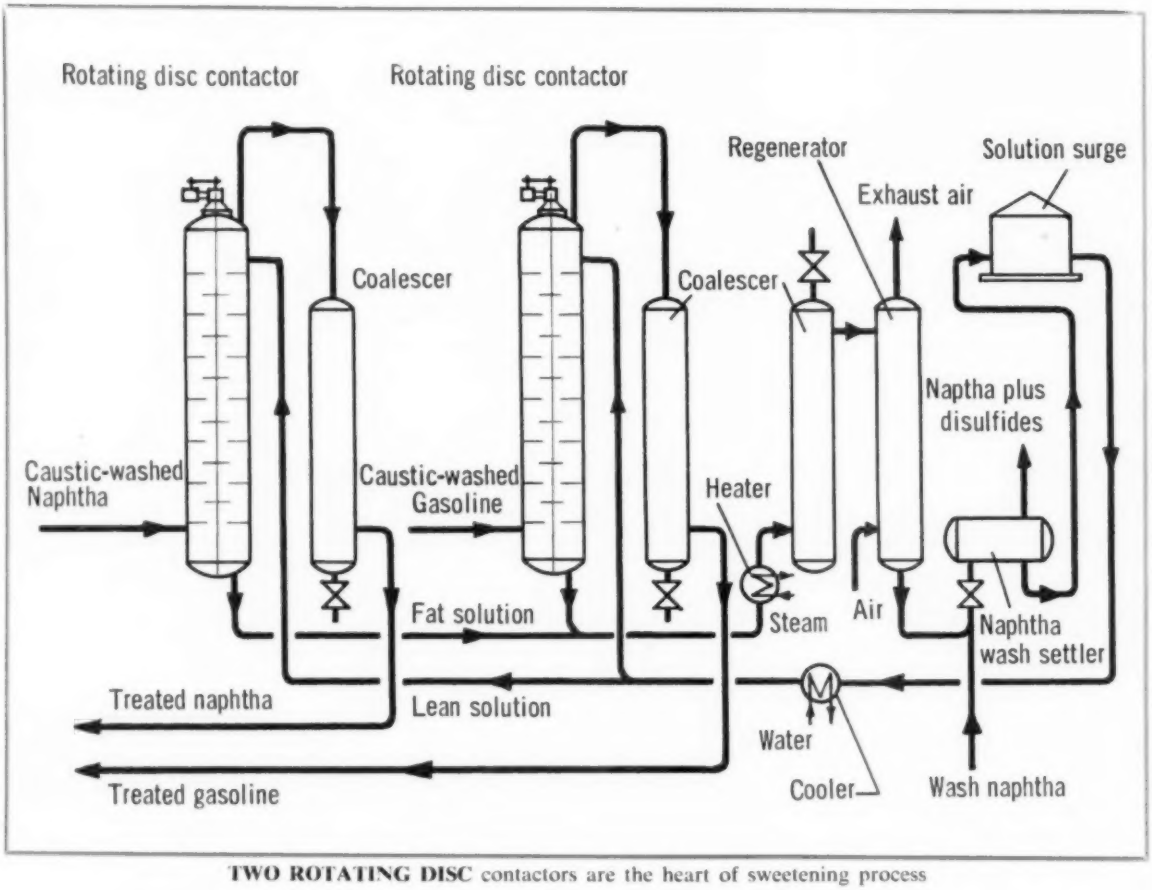
What happens in the sulfur recovery plant is perhaps best illustrated in the following table:

Feed	Vol-%	Product	Wt-%
H_2S	80.8	Sulfur	99.90
CO_2	12.7	Moisture	0.07
Hydrocarbons	1.9	Organic material	0.02
Water	4.6	Ash	0.01

Because the sulfur plant is designed so that corrosive conditions are not created, very little alloy is used in the equipment. Carbon steel is used for all process equipment and piping. Maintenance is low, based on operating experience of similar plants, being usually less than 3% per year of the basic investment.

Design of the sulfur plant was by Ralph M. Parsons Co., procurement and construction by C. F. Braun & Co.

TIDEWATER PROCESSES "another first in U.S."



TWO ROTATING DISC contactors are the heart of sweetening process

SOLUTIZER

By J. A. SAMANIEGO
Shell Development Co.

TIDEWATER'S Solutizer plant at its Delaware refinery removes mercaptans from a light, straight-run gasoline and a heavy, straight-run naphtha. The extraction is carried out simultaneously in two Rotating Disc Contactors (RDC). The spent solutions are combined and regenerated in common facilities.

This is the largest plant in the world and the first in the United States to use Shell's RDC's in this process. Tidewater chose the Solutizer process over other sweetening processes because this process effects sweetening by mercaptan removal, thus reducing total sulfur content and, in the case of gasoline, thereby also improving lead susceptibility. Mechanical design and field installation were handled by C. F. Braun & Co.

The flow diagram schematically depicts the Delaware Solutizer plant. Caustic-pretreated gasoline and naphtha are charged to the RDC's where they are countercurrently contacted with Solutizer solution. The treated streams leave the top of the RDC's and pass through coalescers and then to storage. Fat solutions leaving the bottom of the two RDC's are combined, heated, passed through a coalescer, and charged to the regeneration column where the mercaptans are oxidized to disulfides by air blowing. The solution is then washed with naphtha in a mixer settler, to remove disulfides, and charged to a solution surge tank. The lean solution is then cooled and recylcled to the RDC's.

All light, straight-run gasoline of boiling range C_4 to 200°F is treated in this plant. The design throughput is 13,500 b/sd. The heavy naphtha treated is produced from many types of crude. Its boiling range is 350 to 400°F and the maximum throughput is 5200 b/sd.

The treating agent is a solution of potassium hydroxide and isobutyric acid, its composition is 6 normal potassium hydroxide and 3.1 normal potassium isobutyrate. The mercaptan content of the gasoline is reduced from a maximum of 0.03%-wt mercaptan sulfur to odor sweetness (0.002%-wt or less). The heavy naphtha mercaptan content is reduced from a maximum of 0.10%-wt mercaptan sulfur to 0.005%-wt or less.

The rotating disc contactor is a liquid-liquid extraction apparatus developed by the Shell companies.

it is essentially a disc and doughnut tower with the discs mounted on a central rotating shaft. Settling sections are provided at the top and at the bottom of the tower for separation of the liquid phases.

This extraction apparatus replaces 10 mixer settlers that would otherwise have been required for the mercaptan removal load attending sweetening of the light gasoline and heavy naphtha. RDC's are particularly superior to conventional liquid-liquid extraction equipment in operating flexibility. By varying the rotor speed, it is possible to control the droplet size of the dispersed phase and hence the mass transfer rate. By this means it is thus possible to maintain contacting efficiency as throughput is varied. For a given number of theoretical stages, RDC's require far less plant area than mixer settlers and, in this application where two or more theoretical stages are required, their cost is lower.

Removal of mercaptans from hydrocarbons by extraction with Solutizer solution involves reaction of the mercaptans with potassium hydroxide in the solution to form mercaptide:

$$RSH + KOH = RSK + H_2O$$

In the regenerator, the spent solution is blown with air which oxidizes the mercaptides to disulfides:

$$2\,RSK + \tfrac{1}{2}O_2 + H_2O = RSSR + 2KOH$$

The disulfides are removed from the solution by a naphtha wash. The solution, thus regenerated, is cooled and recycled to the extraction step.

The gasoline RDC at the Delaware Refinery is 6 ft in diameter by approximately 30 ft overall height, including top and bottom settling sections. The corresponding dimensions of the naphtha RDC are 5 ft by approximately 43 ft. The latter RDC is the tallest that has ever been built. Besides top and bottom bearings, the shaft is provided with an intermediate bearing midway between the top and bottom bearings. Except for the bearings which are plug-type graphited cast iron, the RDC columns are entirely of carbon steel.

Utilities for the process are as follows:

Steam (150 psig)	6.6	lb/bbl
Cooling water (20°F rise)	34	gal/bbl
Electric power (solution circulation)	0.05	kwh/bbl
Regeneration air	13	scf/bbl

TIDEWATER's naphtha RDC unit (center) is the tallest ever built

What is the solutizer process?

The solutizer process is a regenerative process for removing mercaptans from sour gasolines. Removal to the "odor sweet" level of 0.001 to 0.003 wt-% mercaptan sulfur is easily achieved. A wide range of straight-run or cracked stocks, either low-end-point or full-boiling-range gasolines can be so treated.

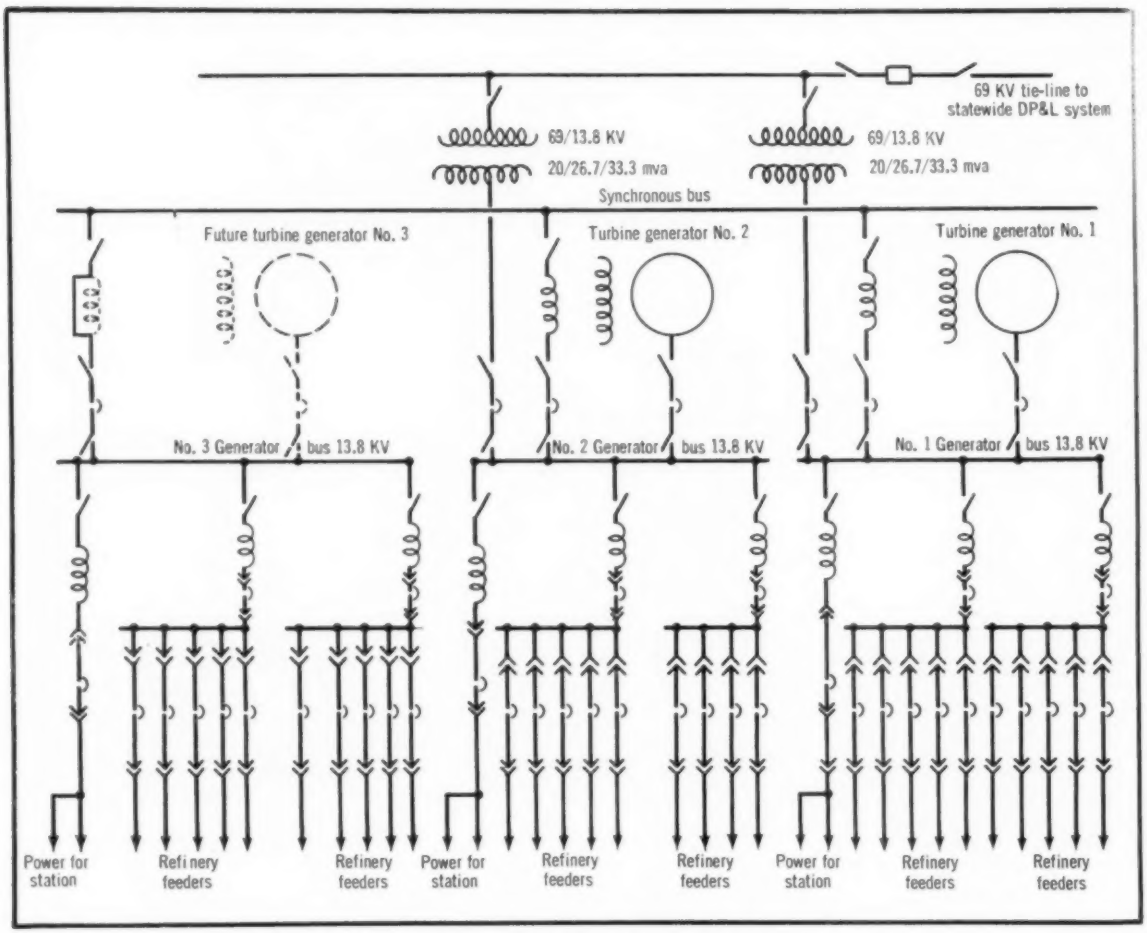
The process has three essential steps: caustic pertreatment, solutizer treatment, and regeneration. Caustic pretreatment removes the acidic components such as hydrogen sulfide and, in some cases, controls the alkyl phenol concentration.

The solutizer step treatment extracts the mercaptan from the sour hydrocarbon feed in a countercurrent flow. The extracting agent is strong potassium hydroxide solution containing mercaptan solubility promoters (Solutizers) such as fatty acids. Propionic and butyric acids, and/or alkyl phenols are used.

In new designs, the Shell Rotating Disc Contactor (RDC) has replaced the older mixer-settler for the mercaptan extraction step. It reduces capital cost and adds significantly to operating flexibility.

In the regeneration step the spent treating solution is heated to 130 to 160°F and the extracted mercaptans are oxidized to disulfides.

No corrosion-resistant metals are required since operating temperatures are low and the treating solution is non-corrosive. Operating costs are low because of simple operation and adaptability to automatic control. The solution is relatively inexpensive and has an extended treating life. Exhaust steam can be used for heating.



HOW TIDEWATER'S POWER IS SPLIT UP for plant distribution

ELECTRICAL SYSTEM

By W. A. BUSSARD
Assistant Editor
PETROLEUM PROCESSING

THE design of the Tidewater refinery required top-notch planning. Perhaps no place is this more apparent than in the careful design of the electrical system.

The original intent was to design a nearly all-electric refinery, with steam turbine drives at a minimum. This goal was not completely fulfilled; however, there are only 80 steam-driven turbines out of a total of 530 drive units. This represents less than 20% of the total number of drivers, although a far larger percentage of total horsepower.

Because reliable operation of the refinery depends upon a constant source of electrical power, every motor within the refinery can obtain power via two separate and distinct paths. The only exceptions to this overall rule are the well water pumps which are scattered throughout 5,000 acres of the refinery site and the marine terminal. Every other motor has an alternate path for its power to travel in case misfortune should overcome one route.

The 40,000 kw of power that operates the refinery leaves the power station via six 13,800-volt switch gear buses. Each bus carries a 1200-amp breaker and subdivides itself into four or five feeder breakers. It requires 27 underground 13.8-kv cable feeders to connect these feeder breakers and the substations. An overhead 13.8-kv line carries power to the marine terminal and to the fresh water wells.

For the first time in such a large refinery, emergency steam drives were

step: economic study of motor types"

kept to a minimum because of the high degree of reliability expected from the electrical distribution system. All 2400-volt power is distributed through a spot network system, which is best described as "one where, if you spot a trouble, it is already taken care of." Normally closed tie breakers eliminate automatic bus transfer, reducing potential damage to large motors if power must be switched from one bus to another. However, on the 480-volt system, a secondary selective system with normally-open tie breakers is used.

Selection of motors received special study because their reliability was of prime importance in a system using a minimum of steam standbys, and it affected design of the overall electric system. The first step in designing the system was an economic study based on the kind of motors to be used. This showed that motors of 125 hp or smaller should be operated on 440 volts and all larger motors on 2300 volts. This resulted in a final count of installed motors of three 3,000-hp, nine of 2,000-hp, two of 1,000-hp, and over 400 motors ranging in size from ¾ to 800-hp.

A more detailed study of those required for large compressors reversed a traditional view that synchronous motors were better for this use. Instead, it was decided to use squirrel-cage induction motors throughout the plant because it was doubtful whether synchronous motors could ride through severe voltage dips. The end result was simpler construction, greater reliability, and lower maintenance.

This decision also affected the final electric layout because it eliminated the need to set up a separate DC excitation system for control of synchronous motors.

Special consideration, of course, was given to the group of nine large 2,000-hp motors which drive the 34,500-gpm cooling water pumps. These motors are the key factor in the operation of the entire refinery—and power plant as well. The decision here was to select totally enclosed fan-cooled induction motors, some of the largest ever built. The importance of this decision is evident when you realize that ⅓ of the power required for the entire refinery is used by this set of nine pumps.

In choosing a steam-driven spare drive, the first criterion was whether or not 40-lb steam would be required in that area for other uses, such as processing, space heating or steam tracing. If so, then the most critical drive unit in that area was selected for turbine standby to help balance the steam load. Otherwise, the standby was an electric-drive, the same as the regular unit, but fed by an alternate source of power.

For large units like the cat cracker air blower and the coker air blower, steam turbine drives were selected for efficient operation. Rather than take a loss in converting steam to electricity, 600-lb steam was used directly in these few large turbine units where the water rate was similar to the turbine-generators in the power house.

Within the refinery, it was found more economical to install the switchgear indoors with the control equipment, and mount the transformers outside. Installed throughout the refinery are thirteen switch houses, each of which receives power from at least two separate 13.8-kv cable feeders. Transformers are in pairs, each connected to an alternate source of power. Bus ducts with vapor seals connect the outdoor transformers and the indoor switchgear. The switch houses are pressurized with air drawn through a vertical duct above the roof.

About two-thirds of the power is distributed throughout the refinery and transformed to 2400 volts, with nine substations supplying this power requirement. The other third is converted to 480 volts in thirteen substations. There are also two 750-kva substations, and 300-kva and smaller transformers for supplying isolated outdoor 440-volt loads.

The two overhead lines—one to the water terminal and south well-water gathering system, and the other directly from the power station to the north section wells—are both protected by aerial grounds. These are scavenging lines that run from pole to pole above the power lines, acting as shields.

Design and construction of the electrical systems for both the refinery and the power station were by C. F. Braun & Co.

Acknowledgement is made to the following for their helpful assistance in providing information for this article: C. W. Boice, senior engineer, C. F. Braun & Co.; and J. J. Dudowicz, electrical co-ordinator, Delaware Refinery, Tidewater Oil Co.; and S. R. Durand, engineer, Pacific Region, Allis-Chalmers Mfg. Co.

Special network analyzer used to study system

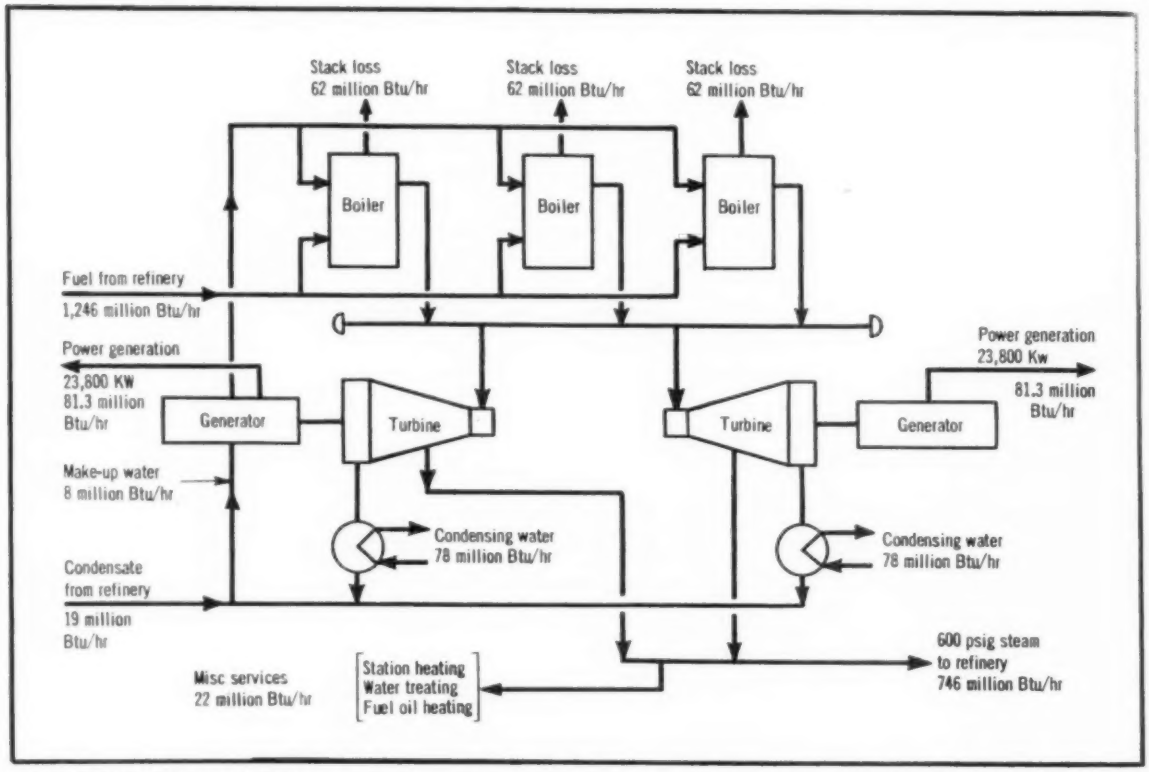
TO guarantee absolute reliability of the electrical system at the Delaware Refinery, the proposed system was simulated on the A.C. network calculating board at the Illinois Institute of Technology, in Chicago. The purpose of the study was to check the operation of the system during severe short-circuit conditions to see if motors would stall or develop voltage or current conditions that might damage equipment.

The first study, in April-May 1955, assumed that there would be three generators, equally loaded with 25 mva. There was no tie-line. This first study discovered that there might be severe motor stalling of large motors on the reciprocating compressors, and that some motors would be reclosed onto the system with high residual and damaging voltages. The time delay drop-out feature for preventing overloads or underloads from completely dropping out the refinery motors did not solve this problem. This required changing the torque characteristics of the motors themselves, and increasing the drop-out time of the 2400-volt starters.

A second network analyzer study was made in August-November 1955, only this time it was based on two generators with an energized 69-kva tie-line. It proved that the tie line can take the full load if both the generators go down. Because no refinery had ever been designed so extensively with a power distribution intended to "ride through" severe system faults, the second study was used to check out all the final circuit and component values.

After some modification of equipment characteristics, the second study showed that even under most severe conditions the electrical system was very stable. And it was felt reliable enough to continue plans for an almost all-electric refinery, with ample protection for continued operation in case of failure somewhere in the system.

"... excess power



HEAT BALANCE DIAGRAM shows where all the generated steam goes. (Taken from AIEE conference paper by William C. Cauthen, C. F. Braun & Co.)

POWER PLANT

By W. A. BUSSARD
Assistant Editor
PETROLEUM PROCESSING

WHEN Tidewater decided in 1953 to build a new refinery on the East Coast, the prime contract was awarded to the C. F. Braun & Co. But in addition to the refinery, Braun was also commissioned by Tidewater in 1954 to design a companion power station to furnish both steam and electric power to the new refinery.

However, in June 1955 there was a change in plans. It was decided that Delaware Power and Light Co. would assume both responsibility and financing of the power station under an unusual setup. DP&L bought the land upon which the power plant was to stand and, backed by a long-term agreement with Tidewater, decided to invest their own money in this semi-captive power station with Braun retained as engineers and constructors. Tidewater would furnish the fuel, essentially fluid coke with supplemental oil and gas, and DP&L would supply the refinery's electricity and most of the steam requirements.

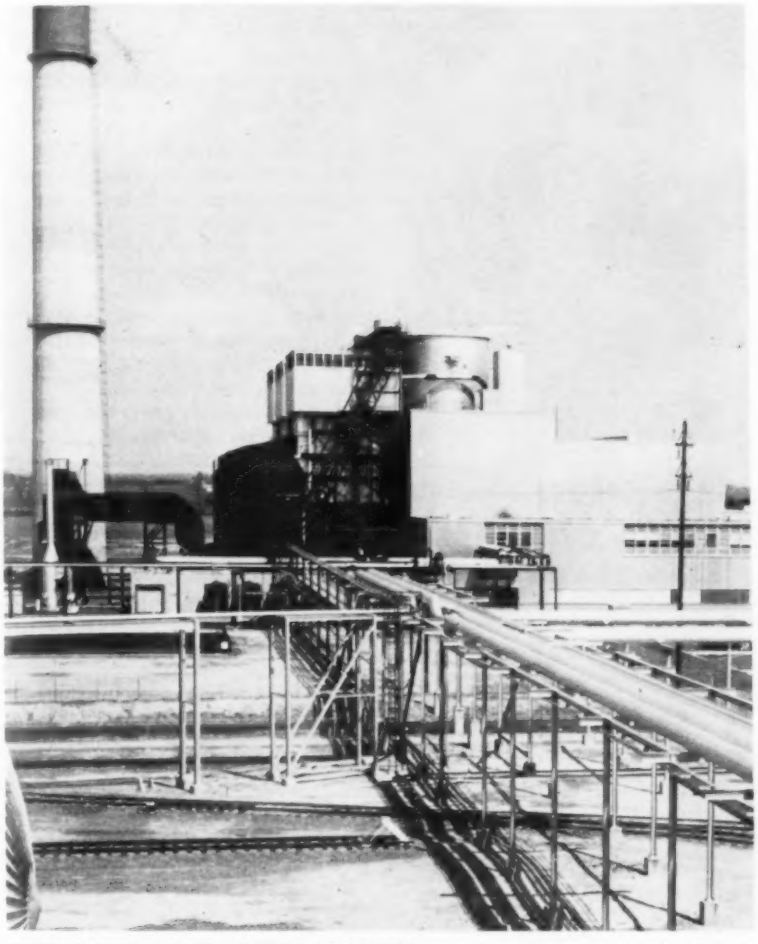
A water treating unit, designed to satisfy requirements of both the refinery and power plant, is operated by DP&L. Because the most critical use for demineralized water is in the high pressure boilers of the power plant, it was natural to give control of this water to the people who would use it. This decision to locate the demineralizer at the power plant also suggested locating the rest of the water treating plant within the power house gates too, and this was done.

Connecting the refinery and the power plant like umbilical cords are three 5-in. fluid coke lines, one to each boiler. When the power plant is receiving its fuel requirements as fluid coke, 90 psig air will convey 75 ton/hr of sand-like coke from the refinery to the power station. Supplemental fuel will be used to bring the hard coke to its high ignition temperature and maintain combustion.

Total ash content of the coke is expected to be a maximum of 0.3%. However, some of the coke may not burn completely the first time through. There are, therefore, provisions for recirculating the fly ash for a second burning. Because the sulfur content of the coke may reach as high as 5%, the power house smoke stack has become the highest point in the state of Delaware. Raising the top of it to 500 ft above ground level assures that any SO_2 fumes will be dispersed safely.

The refinery is not completely dependent on the station for power. A standby feeder ties the refinery into the rest of the statewide DP&L power system and then into the east coast network. It will carry a maximum load of 50,000 kw or the 40,000 kw re-

sold to the state of Delaware"



CONNECTING THE POWER STATION to the refinery are overhead lines carrying the fluid coke; steam lines also connect the two plants

quired for full load refinery operations. The normal operating requirements of the refinery are: steam, 300,000 to 850,000 lb/hr at 600 psig; electric, 18,000 to 42,000 kw.

Steam is generated at 1,300 psig, and used at 1,250 psig and 950° F in the turbine-generators. Steam is extracted at 600 psig and 750° F for use in the large steam turbine drives in the refinery, such as the cat-cracker air blower and the gas compressors. Another steam level of 175 psig at 425° F is used for quenching and process. A third steam level used in the refinery is at 40 psig and 380° F and is used for processing, space heating, and steam tracing. Of the 800,000 lb/hr of 600-psig steam sent to the refinery, some 180,000 lb/hr returns to the power plant as condensate after extracting over 95% of the Btu's.

Although the primary objective of the power house is to produce steam for the refinery, it does convert about 15% of its energy to electric power. The 1300-psig steam from three 500,000-lb/hr boilers is supplied to two 25,000-kw turbine generators of extraction-condensing type. These generate the 40,000 kw needed for full refinery operating load. But, if the refinery demand is low, any excess electricity generated may be absorbed by the DP&L system through the standby feeder and permit the power station to continue operating efficiently.

Another interesting relationship exists between the refinery and the power station. The greatest demand for power in the refinery comes from the cooling water pumps, which require 33% of the electric load for full operation. In turn, the power house is the major user of the cooling water, requiring 45,000 gpm for condensing at the turbines—about 16% of the total cooling water demand.

For burning the fluid coke, special features were embodied in the design of the power house boilers. Because fly-ash from certain crudes has a very high fusion temperature, the furnaces have provisions for adding flux such as calcium oxide or magnesium to the slag bottoms. Special provisions have also been made for measuring the temperature at the bottom of the furnace.

For pulverizing the very hard fluid coke, attrition mills are installed before each boiler. Each is driven by a 500-hp motor and is designed to pulverize the particles from a 60-mesh to a 200-mesh size. This will probably extract a power requirement of about 40 kwh for each ton of fluid coke burned.

What's expected from the power house? The power house at Tidewater's Delaware Refinery, which is owned and operated by DP&L, receives its entire fuel from the refinery—as fluid coke and as oil and gas. In return for this supply of 1,246 million Btu/hr of fuel, the power house is expected to return to the refinery 800,000 lb/hr of 600-lb steam and 38,100 kw of electric power. This is used to operate 80 mechanical-drive steam turbines, 450 electric motors, 500 pumps, and miscellaneous activities.

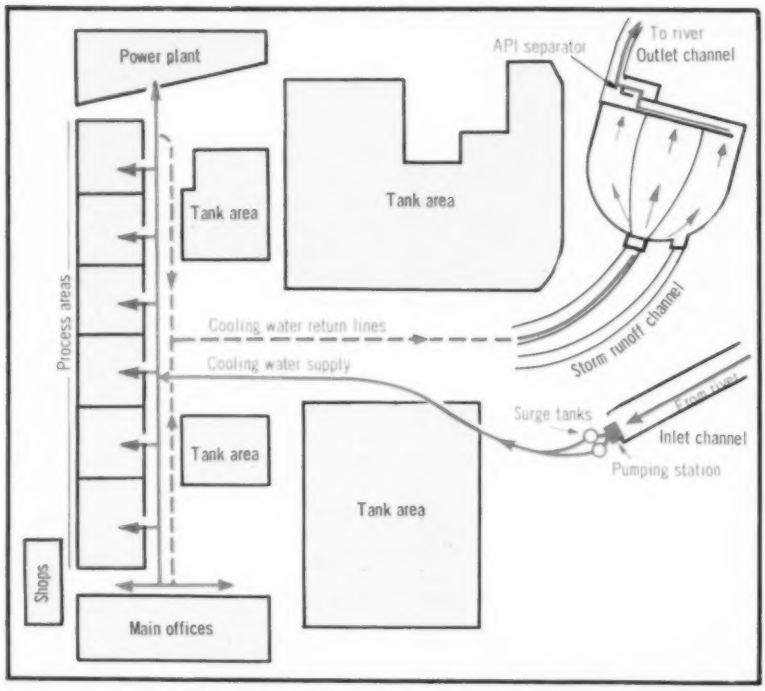
A closer breakdown of the electric load in brake horsepower is as follows:

Use	bhp	Use	bhp
Crude unit	4300	Marine terminal	50
Cracker	1360	Water treating	293
Gas plant	1660	Site	10
Fluid coker	765	Utilities	2357
Sulfur plant	4	Buildings	630
Poly plant	815	Lighting	1300
Alkylation	903	River water pumps	14800
Reformer	1910	Tank farm	1735
Udex	345		
Hydrogen plant	5800		
Desulfurizer:			
Train #1	1460	**Total**	44,415
Train #2	610		
Train #3	795		
Train #4	866		
Train #5	1330		

Acknowledgement is made to the following for their helpful assistance in providing information for this article: W. C. Cauthen, senior consulting engineer, C. F. Braun & Co.; and P. W. Haynie, engineering dept., Tidewater Oil Co., Delaware Refinery; and R. D. Weiner, station manager, Delaware Power & Light.

TIDEWATER SERVICES

"... cooling water



ONCE-THROUGH COOLING WATER SYSTEM, from the river to the river.

WATER SUPPLY

By WILLIAM C. UHL
Managing Editor
PETROLEUM PROCESSING

Two major problems were faced and solved by Tidewater Oil Co. in meeting the water needs of its 130,000 b/d Delaware refinery plus the adjacent 50,000 kw power plant of Delaware Power & Light Co.

1—Sufficient cooling water to remove a heat load of 3-billion Btu/hr.

2—Enough water for all other plant uses: fire, process, power plant, and drinking.

Water comes from two sources of supply and is handled through four separate systems. The supply sources are the Delaware River and wells on the refinery property. One of the systems delivers river water for cooling purposes in the refinery and the power plant, on a once-through basis. Demand for cooling water is expected to be approximately 240,800 gpm (approaching water consumption of a large metropolitan area such as Detroit or Philadelphia). However, the system has been designed to provide a maximum of about 310,000 gpm for peak loads.

The other three systems handle well water. Demand is about 3440 gpm broken down into the following usages —flow to water treater, 2600 gpm; raw water make-up for process units, 540 gpm; and fire water make-up, 300 gpm.

Cooling-water system

The simplified flow chart shows the general arrangement of the once-through system. River water is brought in through a dredged channel, about 1½ miles long, to an intake basin just ahead of the pumping station. Here, debris is removed by moving screens, and possible growth of algae and slime is limited by chlorination. There is no other treating of any kind.

From the pumping station, cooling water flows through two parallel, 78-in. diameter concrete lines to the process area and the power plant. Header length is 4000 ft and lift to the highest equipment is about 75 ft.

A return system brings water back through two parallel, 84-in. diameter, concrete pipes down to about river level. Water then flows through an open channel into three immense separators, and then on through another open outlet channel to the Delaware River. The separators—and other oil separation equipment in that area—are described in a separate article on the waste disposal system, p. 138.

Tidewater made engineering studies and cost analyses to compare three alternate methods for continually removing the heat load of 3-billion Btu/hr. Important conditions that had to be considered included:

1—Unfailing supply.

2—Operating flexibility.

3—Economy in both investment and operating costs.

4—Large quantity of cooling water needed.

5—Use of brackish water.

6—Soil conditions.

7—General topography of the site.

One method contemplated circulating fresh water from wells in a closed system with forced draft cooling towers. The estimated loss of 9,000 gpm by evaporation and blowdown was too great a load on the underground water supply, considering all other demands on this source.

A second method considered the use of a closed system with cooling towers but operating on river instead of well water. However, salinity of the Delaware River runs sometimes as high as 25,000 ppm—almost as much as sea water—and with this method, salinity was expected to increase to as much as 50,000 ppm. Cooling tower manufacturers were reluctant to guarantee performance of their equipment under these operating conditions.

The third method, and that finally chosen, was for once-through circulation of the river water and no cooling towers.

Three design requirements had to be met in this cooling water system: reliability, flexibility and durability.

Reliability was built into the system by careful selection of equipment, by paralleling conduits and certain equipment, by providing spares for the most essential equipment, and by standby power.

Vital equipment can be repaired and maintained without a shutdown. For example, any of the moving screens at the pumping station can be isolated

removes a load of 3-billion Btu/hr"

for maintenance without cutting a single pump out of service. All parts of the system are in multiple, except the inlet channel, outlet channel, and the separator. Continuity of power to the pumps is assured by two sources of electric power and dual feeders to the two substations. The accompanying sketch illustrates the dual feeder arrangement.

Flexibility was a must, particularly during startups and shutdowns of process units. Based on Tidewater's planned turnaround schedule, demand for cooling water could vary from a low of 140,000 to a high of 275,000 gpm, design figures. There are nine Byron-Jackson vertical centrifugal pumps, each with a 34,400 gpm capacity against a discharge pressure of 80 psi, each driven by a 2000-hp Allis-Chalmers electric motor.

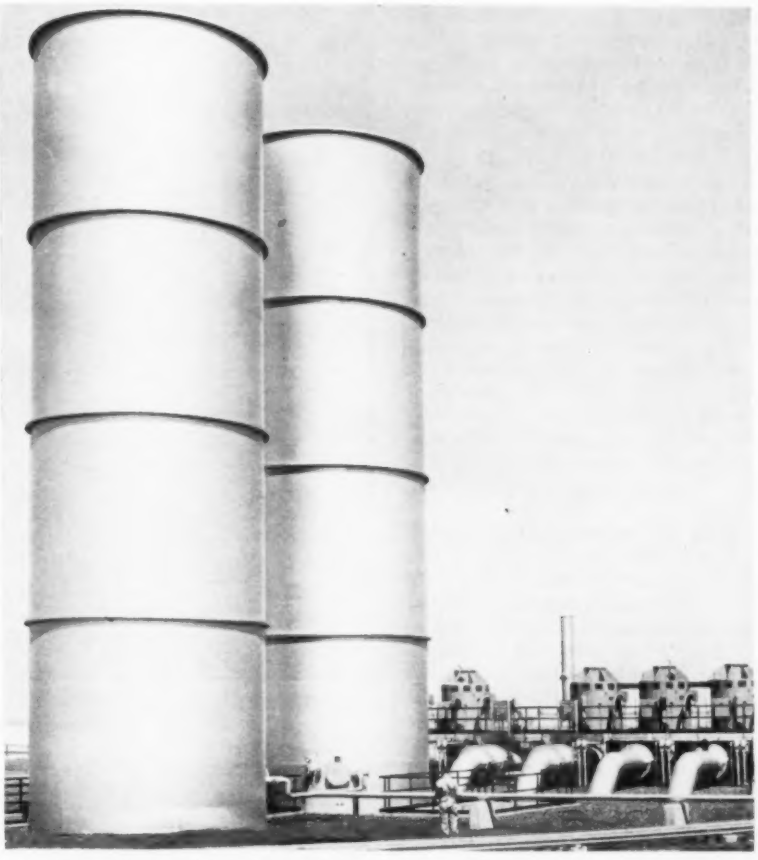
Durability in the system was needed because of the highly saline river water. Alloys were used in screens, pump parts, strainers, and all heat transfer equipment. Steel pipe is lined with concrete, and open channels are lined where necessary for protection against hydraulic scour.

Another problem was the possibility of the river causing a short circuit in the cooling system by returning discharged warm water back to the inlet channel. This was because the tidal condition of the Delaware at this location is such that there is no permanent upstream or downstream. Upstream current at flood tide and downstream current at ebb tide are essentially the same—about 2 fps. And most of the river flow is away from the refinery, across the river.

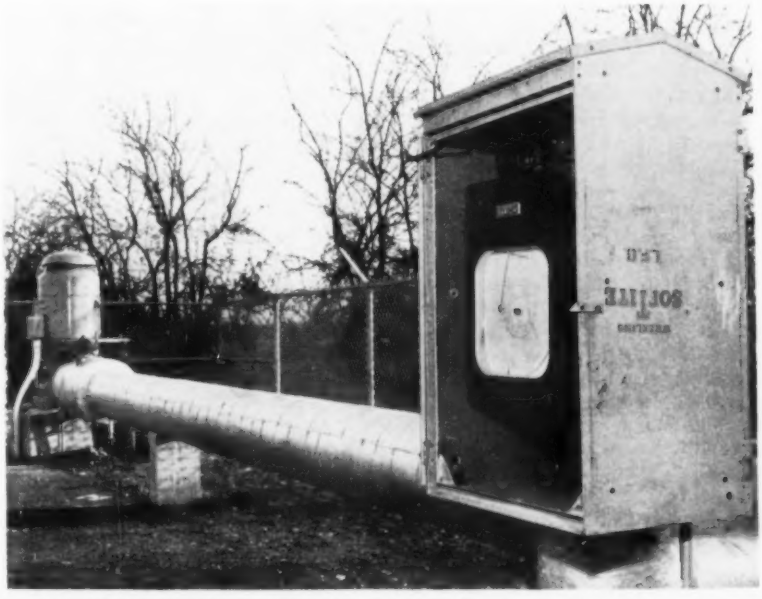
Little or no reliance could be placed on estimating water temperature conditions in the river. Arrangements were made with the Army Corps of Engineers for hydraulic model tests at the Corps' Waterways Experiment Station in Vicksburg, Miss. A model of the Delaware estuary from the Capes to Trenton, N. J., 750 ft long, built to a horizontal scale of 1:1000 and vertical scale of 1:100, duplicated tides, salinity, water intake, water heating by the refinery, and water discharge.

Two flow arrangements were studied in these tests. One, where the inlet channel was located adjacent to the outlet channel, resulted in a temperature rise at the inlet of about 1° F. The other, in which the channels were separated by 3000 ft, decreased the rise in temperature to 0.7° F.

As finally constructed, the channels are 5,600 ft apart, and no appreciable



SURGE TANKS with main cooling water supply pumps in right background



TYPICAL FIELD WELL installation, showing orifice meter run

temperature rise has been experienced.

Location of the pumping station, channels, and guard basins was determined after an extensive soil exploration. Altogether, 300 borings were made, along with many soundings of the river.

Two of the three guard basins, all the open channels, the gate structure, and some flumes were located in the marshland which extends 4000 to 8000 ft inland from the shore line. This land was low, swampy ground with many natural drainage channels. Surface soils were soft and compressible, and contained extensive peat deposits. The soils are as much as 60 ft in depth and lie over moderately-firm to firm cohesive soil. The soil tests included shear, triaxial compression, unconfined compression, consolidation, chemical, and ignition.

Results of the borings and core-tests were useful in choosing a location for the pumping station outside the marshland, and in calculating the stability of channel side-slopes. They also led to the decision to pile such structures which could not stand the large settlements expected in the marshland. The tests also established permissible pile bearing-capacities.

Cost studies were also made in choosing the pumping station site. A shoreline location would have called for longer discharge lines, added to the pumping head, introduced costs for deepwater construction, and required pile foundations. Location in the marshland would have offered but few advantages over a shoreline site.

An inland location beyond the edge of the marshland—that finally selected—shortened the discharge lines, decreased the pumping head, simplified disposal of water during construction, and did not require pile foundations. These advantages more than overcame the cost of dredging the inlet channel needed to reach the station.

Final design of the pumping station and its equipment also involved a series of studies and hydraulic tests. The station has been designed to provide for 12 pump chambers, although only nine are needed at present.

To find the effects on flow conditions, the pump manufacturer, Byron Jackson Co., made hydraulic model tests of the station, using a model-prototype scale ratio of 1:10. Velocity similitude was established by using Froude's law, and the pumps were selected to give correct velocities in the model.

The variables in the twelve tests covered a wide range of operating conditions and various combinations of pumps. Tests also checked on several types of dividing walls to separate pump chambers, on certain inlet-gates being closed to simulate conditions during repair and maintenance, and on various submergence levels for the pumps.

In general, tests showed satisfactory flow conditions when eight pumps were operating in twelve chambers. None of the flows caused troublesome vortexing. Spacing of pumps and distances from screens to pumps proved adequate to straighten out the flow.

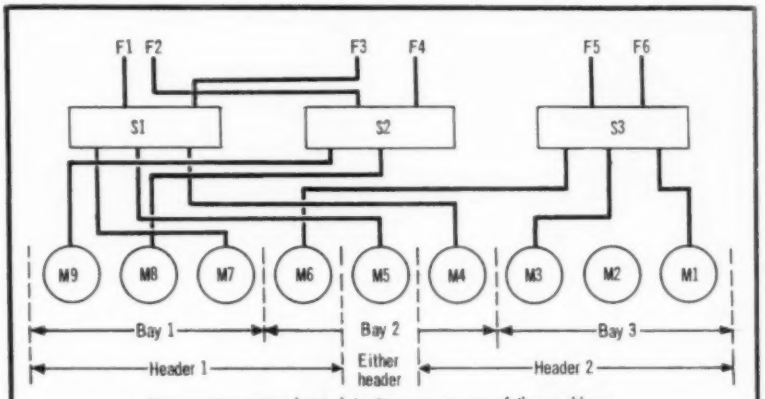
One final problem in the supply system was water hammer. With water flowing through a pair of 78-in. lines uphill against a head of 60 ft, at rates up to 275,000 gpm or more, the water columns would part upon the loss of all pumps, creating a vacuum, until the energy of the flowing water is spent. Then, when the water flows back downhill it would again pack the lines with a destructive water hammer.

This potential headache was solved by installing surge tanks on each line upstream of the pumps, with check valves between the tanks and the lines. Tanks are tall vertical cylinders, 20 ft in diameter by 80 ft in height, and are filled at all times with water. If pressure in the line drops below the static head of the tanks, the check valves open, releasing this stored water into the line, thereby keeping the lines packed with water and averting a water hammer.

C. F. Braun & Co. engineered the cooling water supply system, working in close cooperation with Tidewater engineers. Braun also handled the design, procurement, and construction.

Another problem had to be solved in the cooling water return line. Because of the difference in elevation between the process area and the return water channel—about 60 ft—the flow of some 240,000 to 275,000 gpm could not be allowed simply to run back downhill through the two 84-in. return lines and on into the open channels to the river. It would have washed out most of the open channels and rushed on to damage the navigation channels.

The solution was to install a series of three underground drop structures—like underground waterfalls—which let the water down in three, easy, 20-ft drops. These drop structures are essentially reinforced concrete boxes, with 12-in. walls, measuring about 20 ft in length, 18 ft in width, and 25 ft in height. A 12-in. reinforced concrete



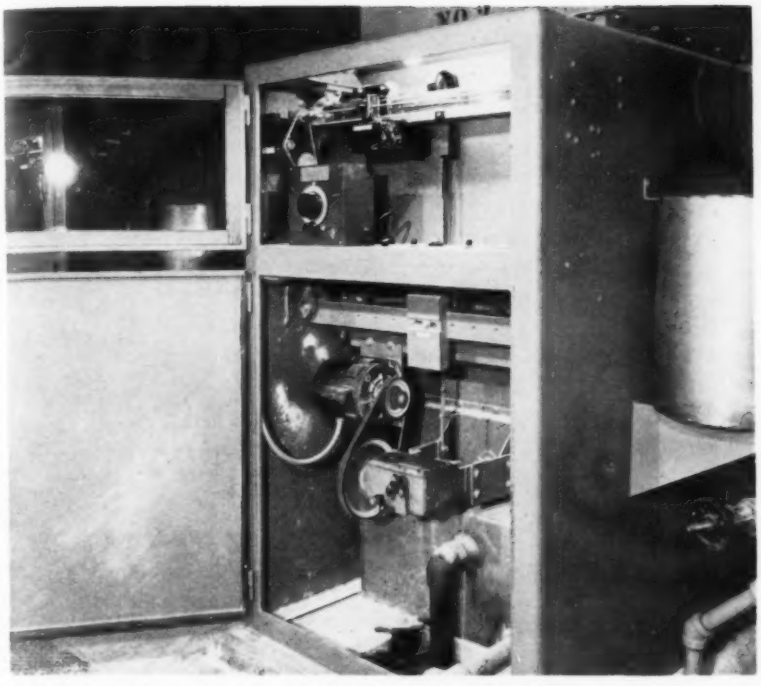
How pumping station electrical circuitry prevents power failure problems:

1 — **Suppose feeder F1 goes dead.** Feeder F3 will carry the power load for substation S1. Pairs of feeders shown pass through separated geographical routes.

2 — **Or, suppose two feeders to a single substation go dead;** for example, F5 and F6 to substation S3? The most that would be lost would be three pumps: M1, M3, and M6. However, only two of these, M1 and M3, are in one bay or in one header. There are still two more pumps in the header, M2 and M4. Furthermore, the spare, M5, can be used.

3 — **In addition to this arrangement** for the pumps, power to a butterfly valve at each pump is automatically backed up by a battery source of DC power. And finally, each valve is hydraulically actuated and has an accumulator to provide enough reserve energy to open and close it once more.

PUMPING STATION POWER FEED IS DESIGNED to protect against problems caused by failures



WATER TREATING IS CLOSELY CONTROLLED as shown in this gravimetric chemical feeder at water treatment plant

partition in them provides two equal-sized turbulence chambers. Water enters at the top and back end of each chamber and flows out of the bottom and other end.

Well-water system

Supply of well water, some 4900 to 6000 gpm, provides a comfortable safety factor for the refinery, being well in excess of the 3440 gpm demand. All this water comes from nine wells, drilled on company property after an extensive exploratory drilling program of about 45 wells.

Exploratory drilling was to three different aquafers. An aquafer is a water-bearing sand layer separated from other aquafers by non-permeable layers of non-water-bearing clay.

The three aquafers and the water production are as follows:

Pleistocene: water in this sand is under water table conditions. Depth runs from ground level down to an average of 100 ft. Tidewater has one production well at this aquafer, producing 1000 to 1500 gpm.

Raritan: average depth is around 300 ft. Tidewater has one production well in this aquafer, producing about 500 gpm.

Patuxent: average depth is about 600 ft. There are seven production wells, varying in output from 400 to 1000 gpm.

Equipment at each well consists of a Peerless deepwell turbine pump—size depending on well output—driven by an Allis-Chalmers motor. Motor hp ranges from 100 to 250 hp, depending on the pump size. In addition to the pumping equipment, each field well site has an orifice meter plus a gate valve to control flow. The orifice meter run is above ground, and it is equipped with electrical strip heaters to keep the piping warm.

The gathering system lines are all underground, below the frost line. They are made up of concrete-lined, mechanical joint, cast iron pipe. Size moves up from 8-in. diameter at the field well to as much as 24-in. where well water finally enters the treating section adjacent to the power plant.

At the treater, water passes through six main steps: 1) aeration, 2) coagulation, 3) clarification, 4) gravity filtration, 5) chlorination, and 6) chemical treatment.

Clear effluent from these treating steps can go several different routes.

1—To filtered water storage, a 50,000-bbl tank. From this point it is chlorinated (to meet drinking purpose standards) for supplying human consumption throughout the property—in the refinery at the power plant, at the marine terminal.

2—To the 1100 gpm Zeolite softener, to produce softened water for process purposes.

3—To the 1500 gpm demineralizer, to produce boiler feedwater for the power plant. This demineralized water joins boiler condensate, treated for re-use.

There is ample storage capacity in the well water system. Besides the 50,000-bbl tank for filtered water at the treater, there is a 28,000-bbl tank for demineralized water and another of the same size for condensate. In the refinery proper, there is a 9,000-bbl tank for condensate and a 9,000-bbl tank for treated water storage.

As in the cooling water system, Tidewater has taken every possible precaution to guard against problems caused by equipment failure in the well-water system. Once each shift, an operator from the main utility dept. control house makes a tour of inspection of the nine field wells.

Should any of the deepwell pumps fail, Tidewater does not plan to tackle the repair job; these pumps are all at the bottom of the wells, a job for specialized maintenance. A. C. Schultes & Sons of Woodbury, N.J., the company that did most of the well-drilling for Tidewater, has the special rigs and equipment for pulling a pump out of the well. The Layne-New York Co., Camden, N.J., also assisted in the well-drilling program.

Operation of the entire water system is the responsibility of the Delaware City refinery utilities dept. There are 23 operators, including two trainees, operating around-the-clock, seven days a week. Five operators are on duty each shift. These men are split up as follows: one at the river water pumping station, three at the main utilities dept. control house (one of whom handles the field well inspection patrol), and one man at the sulfur plant (the utilities dept is responsible for this one process unit).

This group does not include the operators of the treating plant which is operated by the Delaware Power and Light Co.

Acknowledgement is made to the following for their helpful assistance in providing information for this article: R. K. Arzinger, technical foreman, utilities dept., Tidewater Oil Co.; and Henry P. Evans, staff consultant; and Edward E. Elliott, project senior engineer, C. F. Braun & Co.

TIDEWATER SERVICES

". . . oil in water can

FOUR TYPES OF EFFLUENTS are handled in Tidewater's liquid waste disposal system

WASTE DISPOSAL

By ***WILLIAM C. UHL***
Managing Editor
PETROLEUM PROCESSING

KEYSTONE of Tidewater Oil Co.'s approach to the problem of pollution at the Delaware refinery has been, and continues to be, concern for the public. Tidewater's aim is to be a good neighbor to the surrounding community.

This approach is evident through all phases of pollution prevention: in the streams, in the atmosphere, and even in the soil itself. The methods for preventing liquid and atmospheric pollution are described in considerable detail in the following paragraphs. As to soil pollution, there was no extensive or complicated prevention technique. The key factor was relatively simple. All petroleum, gas, and chemical piping was installed overhead. The only buried lines are those for water and for electrical conduit.

The basic principle followed in handling liquid wastes was simply not to mix the various effluent streams. The company's target is to do everything possible and practical to separate valuable oils and unwanted contaminants from the water close to the source.

The Collection Systems

Four basic effluent streams are handled as shown in the simplified schematic flow chart:

1—Cooling water return.
2—Storm water run-off.
3—Oily water.
4—Stripped waste water.

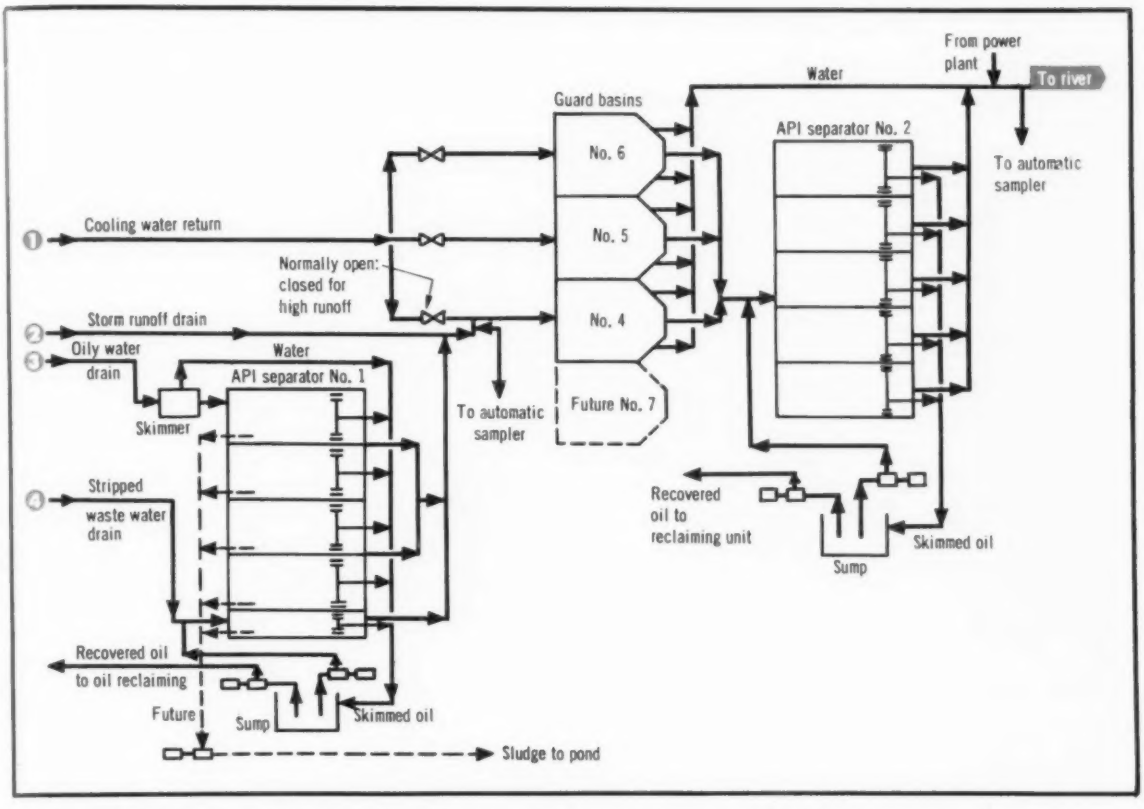
Clear effluent from these streams flows ultimately to the Delaware River. (See separate article describing the plant water supply pp 134-7.) The total flow returned to the river, free of oil and pollution, may range up to 430,000 gpm.

This total is based upon a cooling water return of 260,000 to 275,000 gpm; a storm water runoff of about 164,000 gpm; about 1550 gpm of process waste water; plus the other miscellaneous, smaller flows. The storm runoff is estimated on a maximum 366 cu ft/sec, expected from the refinery's 450 acres of developed land at a 3-in./hr rainfall.

Storm water runoff is all gathered into a single collection system terminating in a 108-in. diameter concrete pipe, which in turn discharges through a 6 x 10 ft box culvert to an open channel leading to the main water system guard basins (see flow chart).

Each of these basins measures about 600 ft long by 7½ ft deep. No.'s 5 and 6, normally for cooling water, are about 415 ft wide. Basin No. 4, nor-

be reduced to less than 5 ppm"



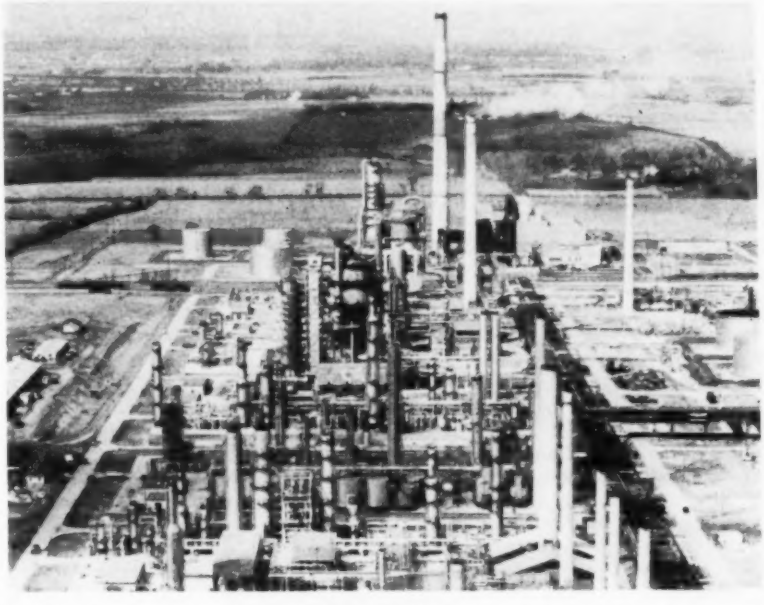
INSURANCE OF CLEAR EFFLUENT reaching Delaware River is provided by this system of separators

mally for storm runoff, measures about 422 ft wide. Adjustable weirs at the outlet remove skimmings to an API-design concrete separator, No. 2. The separators are not of conventional API design. They permit a fairly deep cut—about 10 vol-%—and are of course quite large.

API Separator No. 2 has five parallel channels, each 70 ft long, about 18 ft wide, and with an average water depth of 9 ft. Skimmings from this unit flow to a 10,000-gal concrete sump and then to the refinery's central oil reclaiming unit. Oil-free storm water passes on to the river.

Although not shown in the chart, sanitary wastes from human occupancy areas are treated in septic tanks and treated effluent enters the storm water collection system.

Storm water falling into the storage tank farm usually is held within the diked areas and then released during times of low runoff. Individual outlet boxes permit monitoring the flow from such areas. If oil is present, the flow can be diverted to the oily water sys-



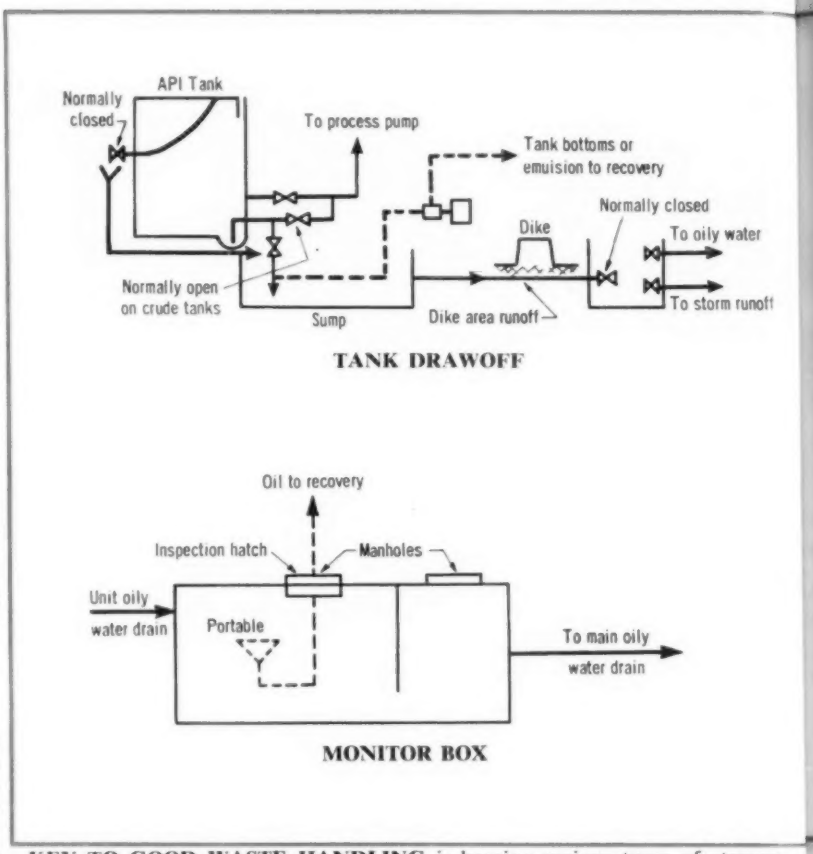
NO ATMOSPHERIC POLLUTION EITHER at the Tidewater refinery. This forest of tall stacks carries gases high in the air for proper diffusion

tem: otherwise flow is directed to the storm water system.

Oily water collected throughout the plant flows through a skimmer and then to API separator No. 1. Clear effluent joins the storm water drain just ahead of guard basin No. 4. Skimmed oil passes through a sump, with recovered oil being sent to the oil reclaiming unit. Four channels, each 170 ft long, 20 ft wide, and about 10 ft deep, in Separator No. 1 handle the oily water.

The stripped waste water, collected in a 12-in. drain, is also handled in API Separator No. 1. It flows through a fifth channel, 10 ft wide but with the other dimensions the same as the first four channels.

Automatic samplers provide a means for checking on the operation of all separators to insure clean discharge to the river. A series of pH indicators in the storm and oil water drains sound alarms whenever pH drops below 6 or rises above 8, indicating presence of acid or caustic in the drains.



KEY TO GOOD WASTE HANDLING is keeping various types of streams

Waste stream separation

The thoroughness of the waste stream separation job Tidewater does is perhaps best exemplified in a description of how it is done at a few typical process units.

At the crude still, the three streams are storm water runoff, oily water, and stripped waste water.

Storm runoff goes direct to the storm water drain.

Waste streams entering the oily water drain include pump drips, some storm runoff and equipment drainings, relief system quench water, pump cooling water, diverted cooling water, a portion of the first stage vacuum condensate, and a portion of the bottom from a foul water steam stripper.

Flow to the stripped waste water drain includes water of that type from the steam stripper and from the flue gas stripper. Other materials from the steam stripper are handled in various ways: some of the separated oil goes to the plant's central oil reclaiming unit, gas goes to the gas plant, bottoms go to the crude unit desalter. Desalter water in turn goes to the flue gas stripper; from that unit, bottoms go to the stripped waste water drain and gas is charged to the crude unit heater as fuel or it is sent to the incinerator.

Somewhat similar devices and handling techniques are used at each of the main process areas, with certain variations depending upon the nature of the waste materials. For example, in the alkylation unit, spent caustic is sent to a caustic disposal unit at the gas plant, spent acids are stored for sales, esters are returned to the process itself.

Waste separators

A number of the separation devices, the monitor boxes, and the like are shown in the accompanying drawings.

The non-process areas have similar devices installed as needed, depending on the nature of the waste materials encountered. In addition, Tidewater has a portable—or mobile—truck unit, for picking up spills and taking this material to the central oil reclaiming unit.

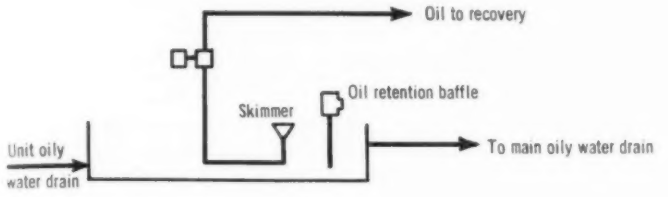
Outside of the plant processing area itself, Tidewater maintains facilities for handling wastes, spills, and leaks at the marine terminal and dock. These facilities include an API separator, and means for skimming up any spills on the surface of the river.

How effective are these various systems in the job of producing a clear, clean, waste-free effluent? Tidewater has found that they can reduce oil in water to less than 5 ppm. Estimates show it has gone from a potential of 95,000 lb/day down to 9,000 lb/day. Other chemicals have been reduced by varying percentages ranging from 82 up to as much as 100% reduction. And suspended solids are being reduced by an estimated 90%.

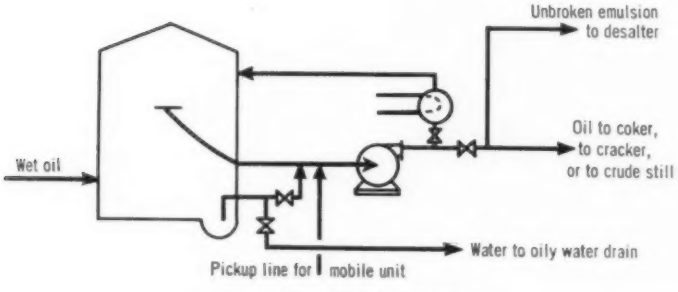
Air-pollution prevention

Tidewater recognized early that the largest single problem in the more than one million SCFM of fluegases rising from the Delaware City refinery was sulfur in the crude oil.

The refinery is designed to handle a crude of approximately 2% sulfur, although this is by no means the maximum it can handle. The extent of



UNIT SEPARATOR


Unbroken emulsion to desalter
Oil to coker, to cracker, or to crude still
Wet oil
Water to oily water drain
Pickup line for mobile unit

OIL RECLAIMING UNIT

separated. Here are four typical separation devices

sulfur is demonstrated in the output of the sulfur recovery unit, up to 375 ton/day from this 130,000 b/d refinery.

Control or elimination of pollutants represented a very real challenge. The State of Delaware has no local or state ordinances for the control of air pollution. As a result, Tidewater turned for guidance to restrictive ordinances from other parts of the country, such as those in the Los Angeles area.

Most of the sulfur is removed by a catalytic desulfurization unit and other product treating units, and is then recovered in a sulfur recovery unit, as explained elsewhere in this issue of PETROLEUM PROCESSING. It should be pointed out that further prevention of air pollution has been made an integral part of some of the liquid waste handling techniques mentioned in preceding paragraphs. Undesirable mercaptans, for instance, are removed in various purification steps and sulfur is recovered from the mercaptans in the sulfur plant.

The spent purification chemicals are stripped of any residual mercaptans, hydrogen sulfide, and other compounds; and the chemicals are neutralized in special strippers to avoid the release of harmful contaminants to the atmosphere.

However, because some sulfur could conceivably pass on through in flue gas—in the form of sulfur dioxide—and because of the nature of flue-gases in the first place, the company made every possible effort to disperse flue-gases into the atmosphere under proper conditions. There are eleven tall stacks to disperse these gases from the refinery and the power plant. All are of concrete construction, lined with sectionally supported brick.

The power plant stack rises 500 ft and is 20 ft in diameter at the top. It is the highest point in the State of Delaware, and special arrangements had to be made by the management with the Civil Aeronautic Authority when the stack height was determined. The other stacks vary in height from 175 to 350 ft, and in diameter from 5 to 12 ft.

Tidewater undertook a very extensive study, calling in outside air pollution consultants, in designing these stacks and determining the heights. The aim of these studies was to choose stack heights for maximum practical diffusion of any possible peak flow of pollutants. All possible variables in wind direction and velocities and in climatic and atmospheric conditions were taken into consideration in the stack height studies.

Good safety factor

As one company engineer described this project: "We aimed at just about the largest safety factor that was economically feasible. We realized that we couldn't design all possible mistakes out of the refinery. Once in a while a human being will err. However, with the present design, a series of mistakes—NOT one single mistake—could occur which might possibly cause an odor. But even then, there would definitely be no damage to plant life in the surrounding area, nor would there be any injury to a human being."

Besides the sulfur problem, Tidewater was concerned with reducing and eliminating smoke and CO_2.

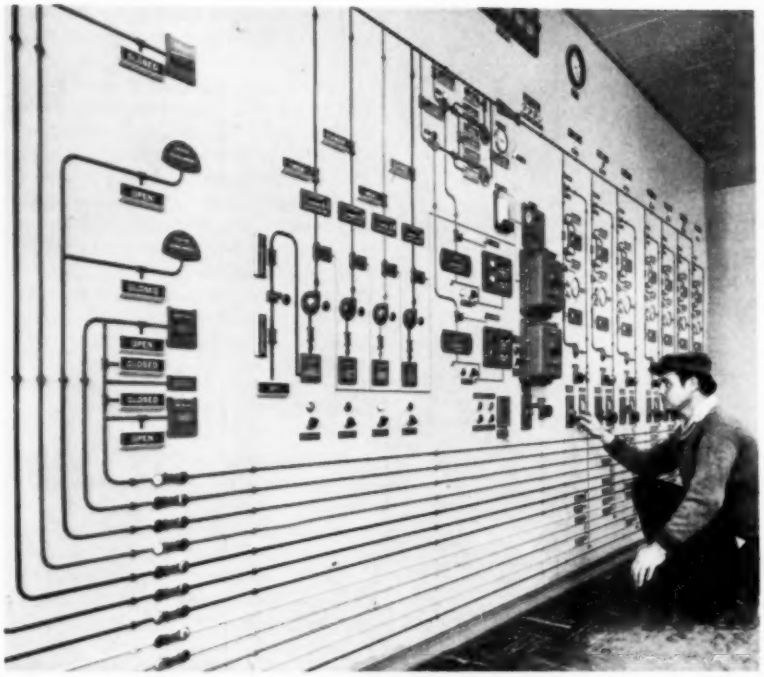
All burners, furnaces, boilers, and combustion controls have been designed to assure a smoke-free fluegas regardless of the type of fuel being burned—oil, gas, or fluid coke. Smoke from flare stacks has been eliminated by two smokeless-type flare stacks handling the refinery relief system gases. These stacks are equipped with automatically-controlled steam-jets, pilot burners, and ignition systems. Both stacks are 225 ft high.

Large quantities of carbon dioxide are produced as a by-product of the hydrogen plant. To avoid any possible concentration of carbon dioxide at ground or operating levels—where human beings work—this gas is also piped into a hot stack and dispersed to the atmosphere at 175 ft.

Acknowledgement is made to the following for their helpful assistance in providing information for this article: A. W. Lewis, supt. of technology; Thomas Magner and Ernest Jeffery, engineers; all with Tidewater Oil Co.; and L. B. Sutherland, senior combustion engineer; D. J. Dobbs and J. M. Phelps, senior engineers; C. F. Braun & Co.

TIDEWATER SERVICES

"... system



GASOLINE BLENDER CONTROL PANEL shows all pumps, valves, and lines to handle seven components. A similar panel controls the other two blenders

PRODUCTS BLENDING

By WILLIAM F. BLAND
Editor
PETROLEUM PROCESSING

IN keeping with the general automatic character of Tidewater's Delaware refinery, even the blending of final products is largely automatic in operation. None of the older batch-blending methods are employed.

Continuous automatic-blending systems, such as Tidewater has installed, add all of the finished base stocks and additives that make up a product in proper proportion and simultaneously in the line, so that at any given moment finished specification product is available directly from the line. In batch blending the individual base stocks and additives are added one by one or in partial combination in a mixing tank—and specification product is not available until the last component has been added and the total blend thoroughly mixed.

Tidewater decided on continuous automatic blending because it was convinced it is faster, reduces inventory needs, allows better control over final products, and minimizes manpower requirements.

Three automatic blenders are installed. Each is a complete unit in itself, and any or all of them can be operated as required.

The three blenders are identified as:

1—Gasoline—which can blend as many of seven base stocks (from a choice of 11, listed in the flow diagram) to make regular, premium, or aviation gasoline. This system also blends in tetraethyl lead mix, a choice of three dyes, and other additives (metal deactivator, antioxidant, corrosion inhibitor).

2—No. 2 Fuel oil—which can blend as many as five base stocks (from a choice of six), plus a sludge preventive additive, to make No. 2 fuel oil.

3—Distillate—which can blend up to three base stocks (from a choice of six) to make kerosine, jet fuel, railroad Diesel fuel, or automotive Diesel fuel. Amyl nitrate can be added to the Diesel fuels (as a cetane improver), or corrosion inhibitor to jet fuel.

All three of these blenders are controlled from graphic panels located in a central control house just south of the finished product storage area.

(No attempt will be made here to describe in detail continuous automatic blending equipment and how it works; that has been done in an earlier article—"Which Blending Method Is Best?" PP, April '56, pp 82-90.)

Blender operation is relatively simple. For any particular product to be blended, the blending operator receives instructions telling him exactly what base stocks and additives are to be blended, and the proportion of each that is required.

He then selects the individual component systems to be used, sets a controller on each one to give the proper ratio of that component to the total blend, and opens the necessary valves in the manifold piping to permit the proper base stocks to be drawn into the blending system.

He next makes a test run to check his proportions. No product is delivered during this run, since each individual component system is on recirculation, but the amount of each component being pumped is registered on a batch counter. If the batch counters do not show the correct amount for each component, he makes adjustments on the controllers as necessary.

When the proportions are correct, he turns his master control switch to the correct position and begins to deliver specification product. This product can be sent either to storage, or delivered directly to a carrier—although Tidewater is not now planning to do the latter. A sample is taken as soon as specification product is being made and is sent to the laboratory for checking.

Safeguards to assure accurate operation have been built into the system. During blending, the actual flow of each component (as well as the rate of addition of TEL) is continuously machine-compared with the amount specified for that component on the control board. Any deviation beyond preset limits automatically stops the entire blending operation.

A master shutoff switch on the central control board and a similar switch at the piers can shut down the entire area in a sudden emergency.

Calibration of any of the flow

practically eliminates contamination"

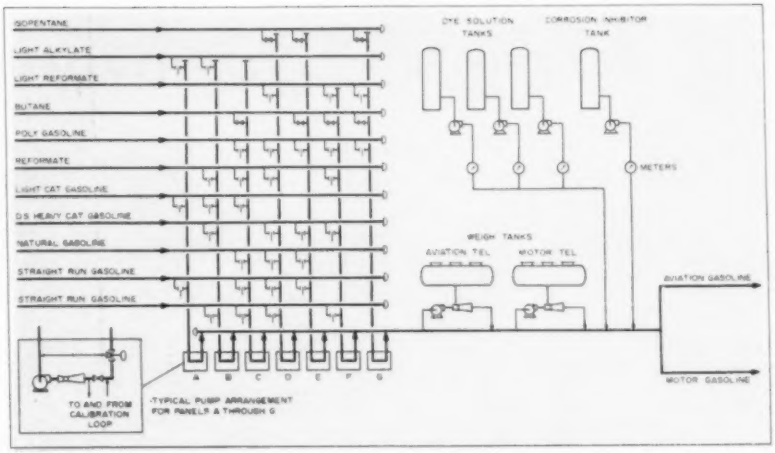
meters in the blending system can be checked at any time—even while the system is in operation. This check is accomplished in a calibration loop, which consists of an 800-ft run of 8-in. pipe, manifolded so that it can be connected in series with any of the component flowmeters. To calibrate a meter, a standard batching pig is launched into the upstream end of the loop. The pig actuates electrical contacts at each end of the loop, which in turn start and stop a batch counter on the meter being checked. Comparison of the recorded volume, as indicated by the batch counter, with the known volume of the loop provides a direct calibration of the meter.

Separate transfer lines are provided for movement of each of the eight products the blenders handle. These run from the blending station not only to the storage tanks but also to the loading racks and docks. Such a system uses a lot more pipe, but practically eliminates any chance of contaminating one product with another. The only place where more than one product moves through the same section of line is in the manifold right at the blending station—and this amounts to no more than 200 ft at the most. These transfer lines range in size from 18-in. diameter (for motor gasolines and No. 2 fuel oil) to 14-in. (for distillate products).

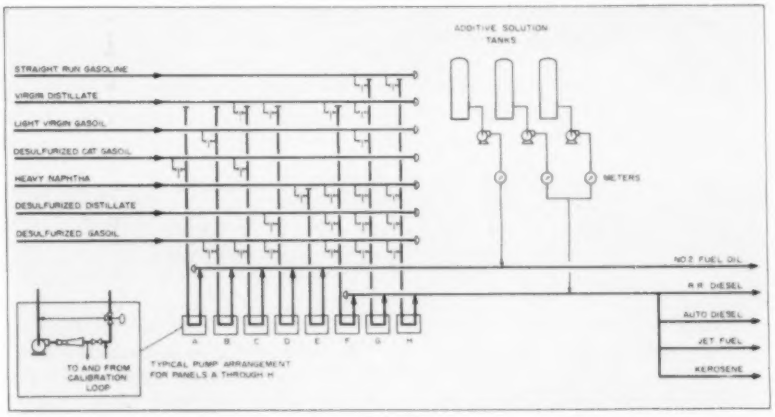
The capacity of the blending system is more than adequate to handle everything the refinery can make. The gasoline blender can deliver at the rate of 10,000 bbl/hr when blending either premium or regular motor gasoline, 4,000 bbl/hr when blending aviation gasoline. The No. 2 fuel oil blender can deliver 10,000 bbl/hr, the distillate blender 4,000 bbl/hr.

Under normal operation, the system is expected to blend 60,000 to 70,000 b/d of gasoline, 30,000 b/d of No. 2 fuel oil, and 20,000 b/d of distillate products—or a total of 110,000 to 120,000 b/d of all products. Obviously the system can do much more than that if conditions require it. For example, once the blender was set up to deliver a particular grade of gasoline, and assuming enough base stocks were in storage, it could deliver 240,000 bbl of that gasoline in 24 hr—almost enough to fill two T-2 tankers.

Manpower required to operate the blenders includes a regular staff of three men per shift (three shifts a day, seven days a week), plus four additional men on the day shift (five days a week). This crew handles all blending, transfer of blended products to storage and to the marine terminal for shipping, tank car loading, transfer of crude from the marine terminal to storage, and receipt of natural gasoline, butane, and additives. Tank truck loading is a separate operation.



GASOLINE BLENDING FLOW DIAGRAM, showing the 11 base stocks (listed at left) and the 7 component systems (panels *A* through *G*). Each component system can be used to pump a chosen base stock—as indicated by the valving—but only one base stock into any particular blend. The same stock, however, can be pumped through more than one component system at the same time



FUEL OIL AND DISTILLATE BLENDING. Although shown as one diagram and arranged on one control panel, these are actually two separate systems. Panels *A* through *E* comprise the No. 2 Fuel Oil Blender: panels *F*, *G*, and *H* the Distillate Blender

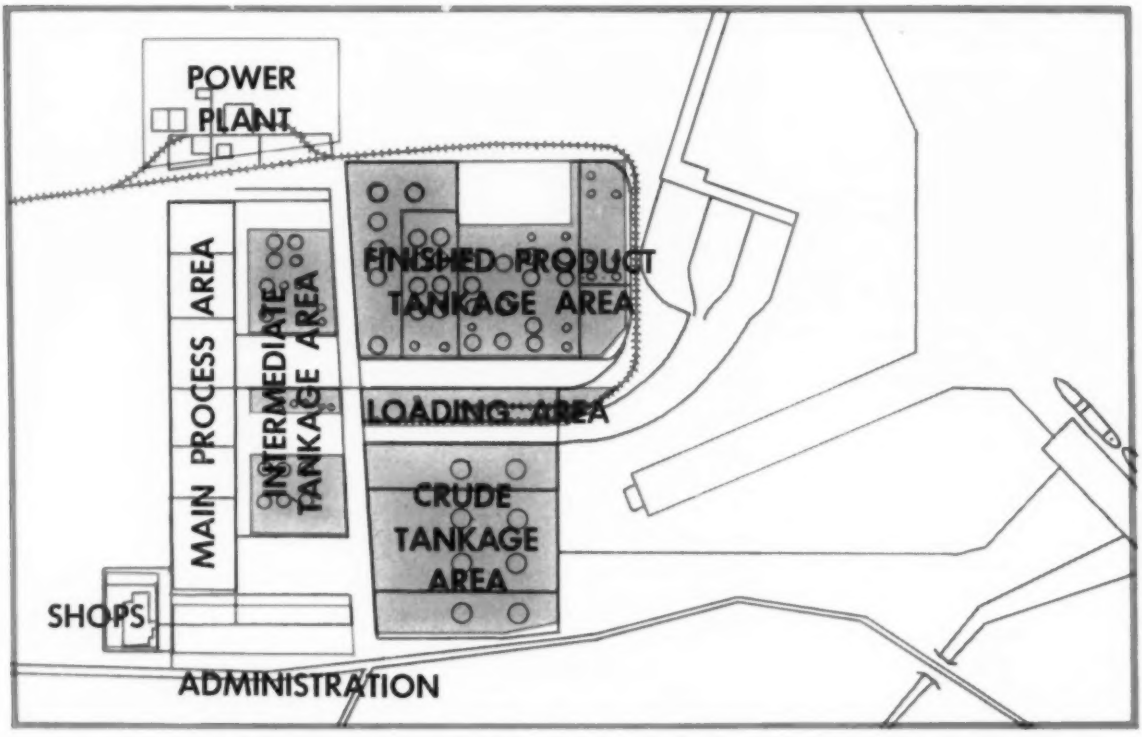
No. 6 fuel oil is blended in a separate installation. Gasoil cutter stock is added to vacuum residuum from the crude unit, and the viscosity of the mixture is measured with a continuous recording viscosimeter. Output from the viscosimeter is used to control the flow of cutter stock to meet viscosity specifications.

The blending equipment was designed and supplied by Proportioneers, Inc., the lead-handling system by E. I. DuPont de Nemours and Co. Engineering, design and construction of the total blending installation was handled by C. F. Braun & Co.

Acknowledgement is made of the helpful assistance provided by the following in supplying information for this article: S. E. Roth, instrument coordinator; and R. M. Hunt, supt. utilities, oil dispatching and sulfur plant, Tidewater Delaware refinery; R. N. Wimpress, chemical senior engineer, C. F. Braun & Co.

TIDEWATER SERVICES

". . . floaters and



LOCATION OF STORAGE AREAS with respect to rest of Tidewater's refinery

TANKAGE

By ***WILLIAM F. BLAND***
Editor
PETROLEUM PROCESSING

TANKAGE at the Tidewater refinery was planned as an integral part of the entire project—and with as much thought as was given any other service facility. As a result refinery tank farms include a number of novel features:

- Installation of some of the largest tanks ever built (200,000 bbl), and standardization of the height of all cone and floating roof tanks at 56 ft.
- Remote gaging and temperature measurement, coupled with a data reduction system for computing the corrected volume of any given tank at any time.
- A tank numbering system which not only identifies each tank but also tells what service it is in, the type of tank, and its capacity.

A total of 86 tanks was installed in the refinery tank farms for the storage of crude, intermediate stocks, and finished products. They have a combined capacity of over 7,500,000 bbl, and include 47 floating-roof tanks, 19 cone-roof tanks, and 20 pressure tanks (12 horizontal bullets, five Hortonspheres, and three Hortonspheroids).

The floaters and cones have all been standardized at 56 ft height, and range in diameter from 60 ft (28,000 bbl) to 160 ft (200,000 bbl) by increments of 20 ft. All but two of the tanks with capacities of 112,000 bbl or over (120-ft diameter) are floaters; the two exceptions (one of 112,000 bbl and the other of 153,000 bbl) are cones used with gas blankets. All stocks with flash points lower than kerosine are stored in floaters.

Tankage is arranged in three general areas as shown in the accompanying plot plan:

1—Crude Tankage—which includes eight 200,000-bbl tanks, with a total capacity of 1,600,000 bbl—enough crude to supply the plant for about 12 days. Space is provided for four additional tanks.

2—Product Tankage—which includes 57 tanks. Each of these tanks, except six general service tanks, is used for the same product consistently—thereby minimizing the possibility of product contamination. Six general service tanks have a capacity of 200,000 bbl each, and are used as needed to store intermediate stocks in the event of a shutdown on one of the processing units, or to build up inventories of a particular stock or product.

3—Intermediate Storage—which includes 21 tanks immediately adjacent to the process area, and which in turn is divided into three smaller areas.

In addition to the 86 crude and product tanks, the plant also includes 27 "on-plot" tanks and 26 "utility" tanks. These are used for such items as chemicals, catalyst, sulfur, coke, water, additives, and the like.

Remote gaging of all crude and product tanks is one of the more advanced features of the Tidewater installation. The height of liquid in any

cones are standardized at 56-ft height"

of the 86 tanks can be read to the nearest hundredth of a foot on a console in the control room merely by flipping a switch.

Each of the tanks is equipped with a Shand and Jurs level transducer, which produces as an output a voltage proportional to the height of liquid in the tank. This output is produced on a ten-turn "foot" potentiometer and a vernier "inch" potentiometer driven by a float mechanism, and is converted to a digital value in the data reduction system.

The average temperature in any of the tanks can also be read on the same console. This temperature is obtained by using four resistance bulbs mounted on a boom inside the tank. One end of the boom is pivoted to the bottom edge of the tank, while the other end is buoyed to float on top of the liquid in the tank—thereby positioning the bulbs so as to measure temperature at four different heights within the liquid and at varying distances from the wall of the tank. The four temperatures are averaged and converted to a digital value.

A data reduction system is now being developed for the Tidewater installation by Panellit, Inc., which will take these two variables for any given tank—height and temperature, feed them into a specialized digital computer, and automatically register the volume of liquid in that tank corrected to 60° F for the particular liquid in storage and for geometrical oddities in the tank.

Tank numbering for identification purposes follows a system developed by Tidewater to give as much information about a tank as is practical.

It consists of a 3-unit code, such as "8-TF-200" or "150-TC-78." The first unit identifies the general area of service the tank is in, the second the type of tank, and the third the capacity, according to the following system:

1—Service: All tanks are grouped into one of five general types of service—and a block of numbers assigned to each one:

1-19—crude oil storage.
20-99—intermediate storage.
100-299—product storage.
300-399—on-plot tanks.
400-499—utility area tanks.

Each block of numbers is large enough to provide for future expansion.

2—Type of tank: Here, "TC" is used to identify a cone roof tank, "TF" a floating roof tank, and "TP" a pressure tank.

TYPICAL TANK AREA SHOWS several types of construction

3—Capacity: The size of a tank is given to the nearest full 1000 bbl, with tanks of less than 1000 bbl capacity identified with the letter "M."

Thus, tank 8-TF-200 is in crude oil service, has a floating roof, and a capacity of 200,000 bbl.

Construction of the bulk of the tankage was handled by Chicago Bridge & Iron Co. Erection was started late in August, 1955 with one small crew. By Jan., 1956, however, there was a total of 13 crews on the job, employing approximately 200 men. This peak lasted through Feb., 1956.

Testing got under way early in the spring of '56, as soon as pipelines were available for moving and transferring water to the tanks. All erection and testing was completed by July 1, 1956.

Welding of the large-diameter tanks (60 ft and over) was done on the horizontal joints with CB&I's patented automatic girth seam welder. With this device a ring of plates is set in position and tack welded. The automatic welder is then set astraddle the ring and rides around the tank on the top edge of the ring, welding the bottom edge from both sides simultaneously.

Automatic welding of this type results in 100% fusion and penetration of horizontal joints, according to CB&I engineers, and eliminates the residual welding stresses. These stresses are a restraint, causing pinching-in, which occurs when welding of both sides is not done simultaneously. The increased quality of such welded joints is credited with making it practical to build tanks of the capacity that Tidewater is using without danger of a subsequent failure.

To ensure safe construction of the tanks, Tidewater did not use standard steel plate throughout. Instead, a tougher steel with high impact strength (ASTM 131 Grade B) was specified for all plates of 7/8 in. and more in thickness. In addition, all fittings, manholes and connections in this special steel were shop installed and stress relieved.

All welds were X-rayed in accordance with the required code under which the tanks were erected. Inspection and grading of X-ray films were covered by customer inspector and CB&I welding supervisors. On the Hortonspheres, Tidewater's insurance underwriters inspected and graded the X-ray films along with the other inspection departments.

Spacing and diking practices followed in laying out the Tidewater tank farms are generous—but not excessive.

Each crude tank is individually diked.

All tanks containing stocks with flash points lower than kerosine are placed in diked areas with a capacity equal to that of all tanks in the area. No more than six tanks are located in such an area.

Hot tanks subject to boil-over are handled as low flash point tanks.

All other tanks are placed in an area diked to hold 100% of the content of the largest tank plus 20% of the content of the rest of the tanks in the same diked area. Again, no more than six tanks are within a diked area.

Acknowledgement is made to the following for their assistance in providing information for this article: Robert M. Hunt, Supt. of Utilities at the Tidewater Delaware Refinery; E. N. Zimmerman, Chicago Bridge & Iron Co.

TIDEWATER SERVICES

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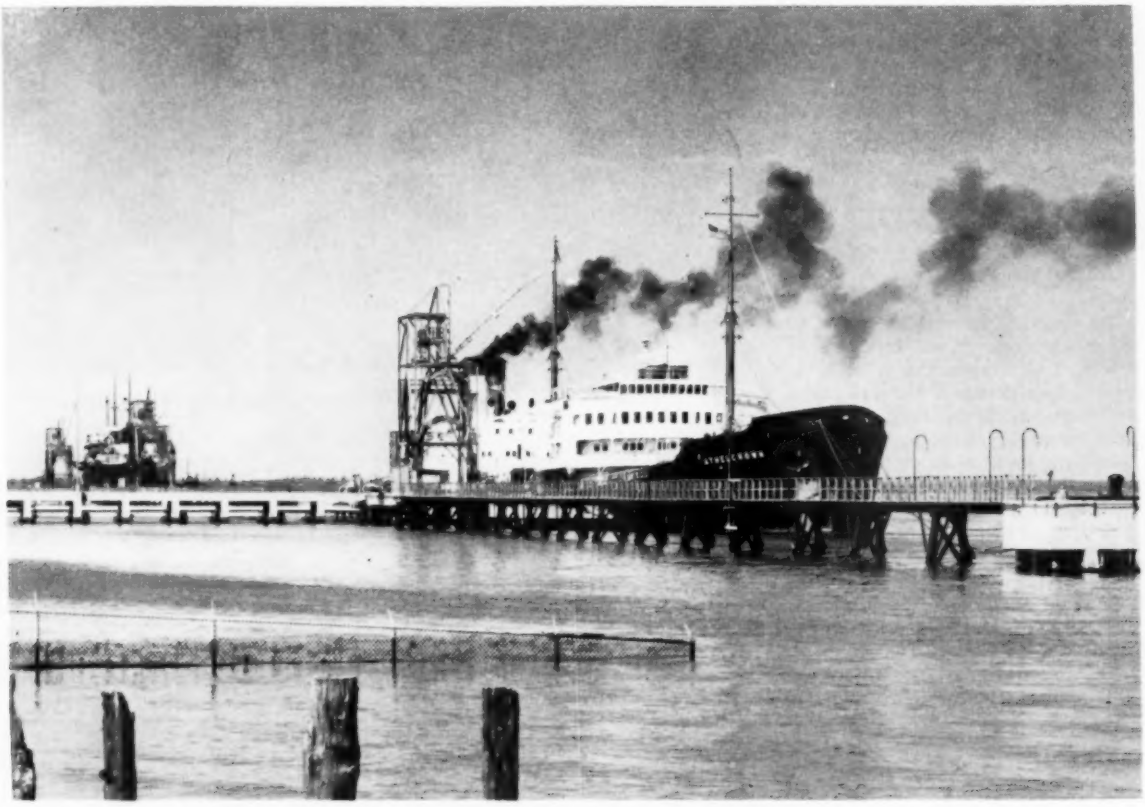


PIERS CAN HANDLE TANKERS up to 52,000-ton in size. Two of the three piers are shown in this picture

MARINE TERMINAL

By VIRGIL B. GUTHRIE
Associate Editor
PETROLEUM PROCESSING

THE marine terminal of the Tidewater Delaware Refinery was designed to operate with a minimum regular pier crew. Extra labor requirements, such as tying up ships, are met by drawing men from the general service groups as needed.

The main reason a minimum number of men can handle the work was the development and installation by Tidewater and Braun of a new type hose-handling structure that allows them to connect or disconnect the heaviest hoses as ships unload and load. Formerly it took several men to maneuver the hose from the dock to a ship nozzle.

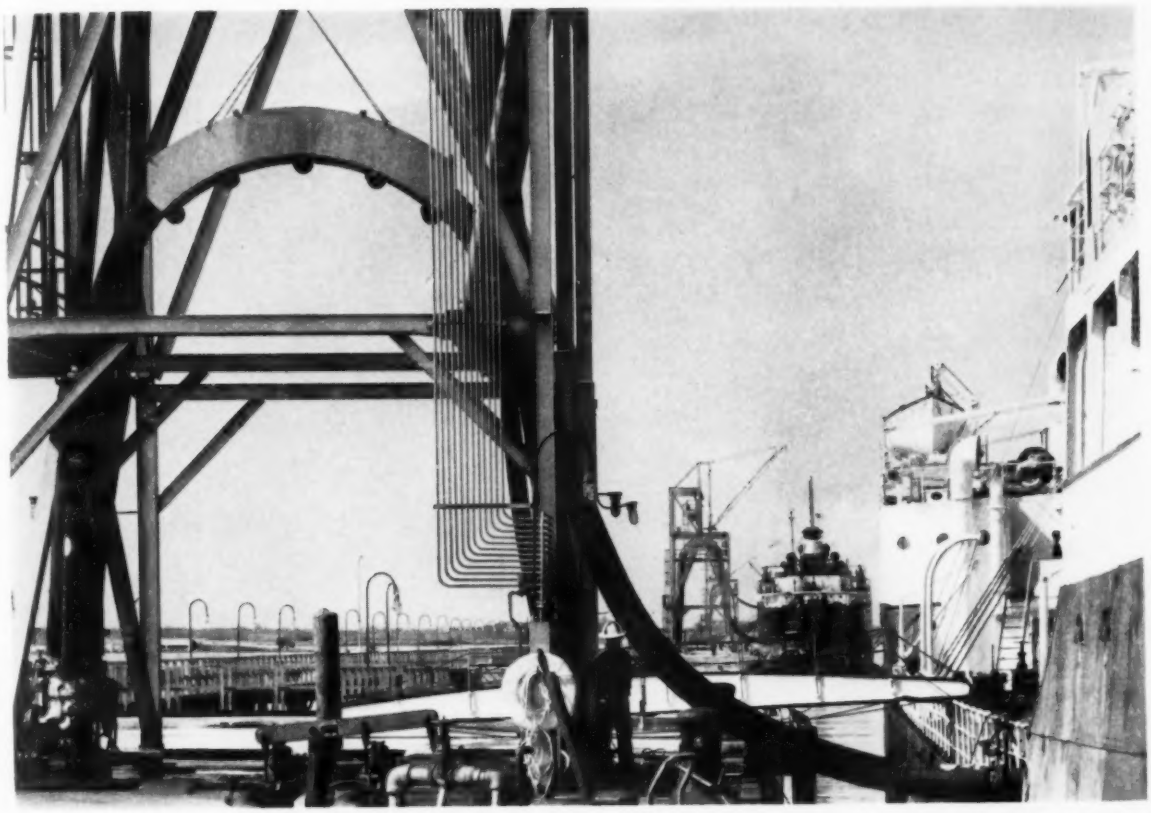
Each pier supports one of these hose handling steel structures, which consists of a 68-ft high steel tower topped by a two-ton, 40-ft boom operated by three, 3500-psi air winches. Up to eleven hoses are racked in each tower, each 75-ft hose length supported on individual cradles with steel rollers which allow the hose to extend and retract smoothly. The boom handles a load line that positions the end of the hose at the ship's nozzle.

From a pushbutton station on each pier, a single operator controls the hose winches, booms and loading pumps. The vessel crew handles the loading or unloading when the hose is connected.

Other equipment installed at the Tidewater terminal to save on hand labor are mooring dolphins between the piers with electric capstans which take a ship's bow and stern lines, and breasting dolphins at the end of each pier which take the spring lines. The piers are connected by trestle catwalks. Each of the two-man regular crew has a jeep to transport tools and equipment from pier to pier. Automatic stop switches in a panel on each pier shut down the pumps for the product loading lines at the refinery one and a half miles distant.

As a part of the engineering study by Tidewater and Braun for the marine terminal, the good and bad features of 10 modern refinery docks were analyzed. The location, on the refinery property, was determined largely by the proximity to the tankage area, for the shortest possible pipeline length, and proximity to the main river channel for least possible dredging. A two-mile, 40-ft channel was dredged from the main Delaware River channel to the docks. Ships maneuver in a turning basin 1500 ft wide and three-quarters of a mile long.

modern refinery docks were studied"

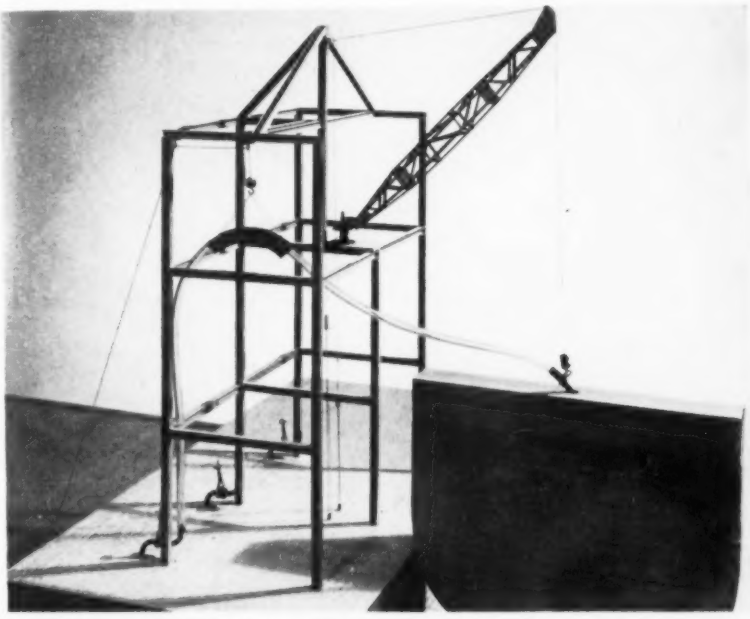


HOSE-HANDLING FACILITIES were designed to improve manpower requirements at Tidewater's marine terminal

Crude oil for the refinery and a major part of its products pass through the marine terminal. Three large T-headed piers can serve vessels ranging from river barges up to 52,800-ton tankers of the Tidewater ocean fleet and even larger tankers when built.

Pier 1 is for unloading crude only, the ship's pumps furnishing the unloading power. Pier 2 unloads crude and loads nine products. Pier 3 loads products only. Each pier can furnish ships with water, fuel and other supplies. Crude is unloaded through a 30-in. line. Product lines are 6- to 18-in., each product having a separate line. Products handled are: regular and premium gasoline, aviation gasoline, jet fuel, kerosine, two grades of diesel fuel and two grades of heating oil. Pumps at the blending unit supply the power for the loading lines.

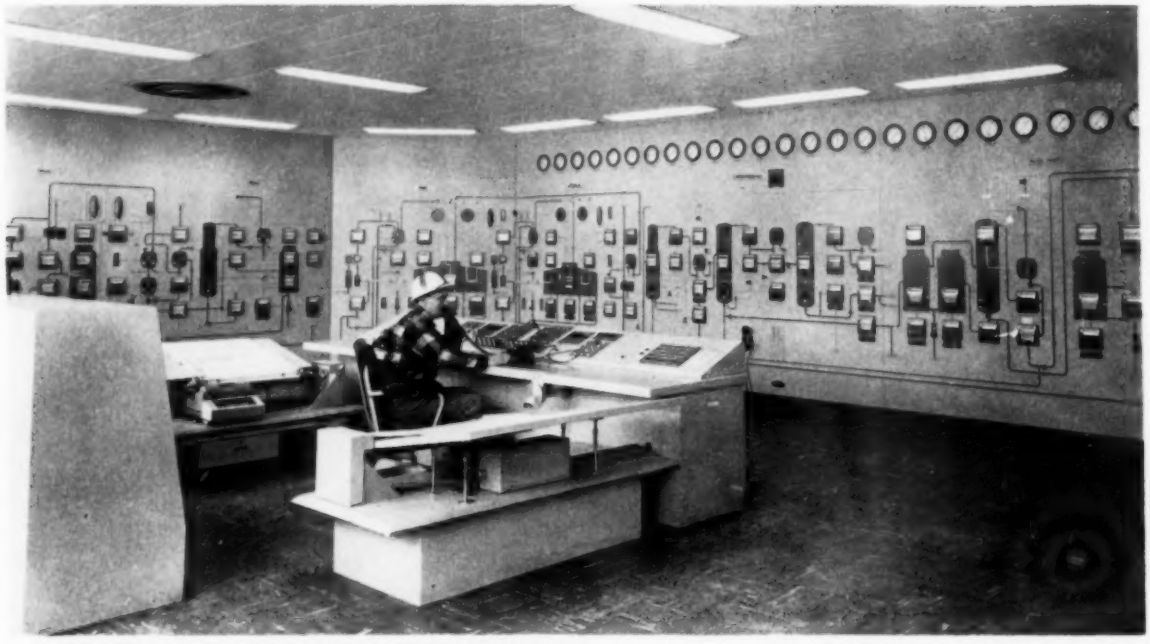
Spoils produced from dredging the river for the terminal and channel were used to reclaim 700 acres of marshland adjoining the terminal area. This operation required 14,000,000 cu yd of silt and raised the area 12 ft above mean sea level.



WORKING MODEL USED TO DEVELOP and make engineering studies that lead to the new hose-handling structure

TIDEWATER SERVICES

". . . had sound



GRAPHIC PANEL IS LOCATED CONVENIENT to information system console in each control center

INSTRUMENTATION

By ROBERT L. DAVIDSON
Associate Editor
PETROLEUM PROCESSING

OUTSTANDING features of the instrumentation at Tidewater's Delaware City refinery are:

1—Use of pneumatic instruments for most of the plant.

2—A logging-scanning information system integrated with the conventional graphic panels and instruments in each of eight control rooms in the refinery.

3—Standardization of components.

Early discussions were held between Tidewater, Braun, and (for the information system) Panellit to settle on a basis for design and selection of instruments for the refinery. This early planning aided in designing the control boards, information systems, and control houses as an integrated whole.

Pneumatic instruments favored

Tidewater had several sound reasons for going the pneumatic route instead of the electronic approach. The prime reason: at the time the refinery was on the drafting boards, there was a lack of a standard electronic signal among the various manufacturers, and Tidewater did not want to be tied to one supplier.

Two other reasons were: 1—many of the employes had been transferred from the older Bayonne, N. J., refinery and, therefore, were familiar with pneumatic instruments, and 2—centrally located control centers at the new refinery kept most transmission distances to an average of 250 ft so that speed of response was not critical for control of the processes involved.

In a few cases where the instruments were too remote, electronic instrumentation was used. Where the runs were over 250 to 300 ft, booster relays were installed, and for critical services field mounted controllers were used.

All instrument tubing (over 400 miles of it) was of copper in bundles of 19 tubes each, splitting into bundles of 4, 7 and 12 after the terminal boxes. These tubing bundles decreased installation time greatly. In some cases, 500-ft lengths of the 19-tube bundles were pulled over as many as seven right-angle bends, and in only one case was there any tube damage.

There are 900 flowmeter points, 300 pressure points (not including gages), 350 level controllers (not including gages), 120 temperature controllers, 1400 thermocouples, 400 dial thermometers, 1000 control valves, 23 oxygen analyzers, and a number of pH gages and other instruments in this refinery.

Information systems and control centers

There are nine control rooms for the refinery. Seven control rooms serve eleven process units, one serves the utilities unit, and one is for the tank farm and products blending operations.

Two major assemblies, a graphic panel control board and an information system (data logger-scanner, tape punch, trend recorders), both furnished by Panellit, form an integrated instrumentation system in each control house. Process control is centralized on the control boards, and graphic panels are provided for all refinery units except the utilities unit. All board-mounted instruments are miniature pneumatic receivers.

reasons for going the pneumatic route"

The operating console is located so that the operator is no more than 15 ft from the graphic panel. This is close enough to see any indicators or recorders that are deviating from the control point, even though absolute values cannot be read at this distance.

The instruments on the graphic panel are no higher than 63 inches and no lower than 33 in. above the floor. This limitation is for operator convenience.

The trend recorders are back of the operating console. On top of each trend recorder is a TelAutograph which writes information received from remote stations and gives results of lab tests to the operator without having to wait for a messenger to bring the test slip.

Utilities indicators in every control room are mounted above the graphic portion of the graphic panel. The indicators are always in the same sequence, so that an operator from another control room immediately knows where to look for a specific gas, steam, water, or other utilities gage.

The information-systems installation receives more information in Tidewater's central control rooms than at any other plant in the country. There is capacity for 4700 points. The largest of the control room information-systems has capacity for 600 points, the smallest 125 points. Inputs for flows, pressures, temperatures, levels, and other process variables are pneumatic and electric.

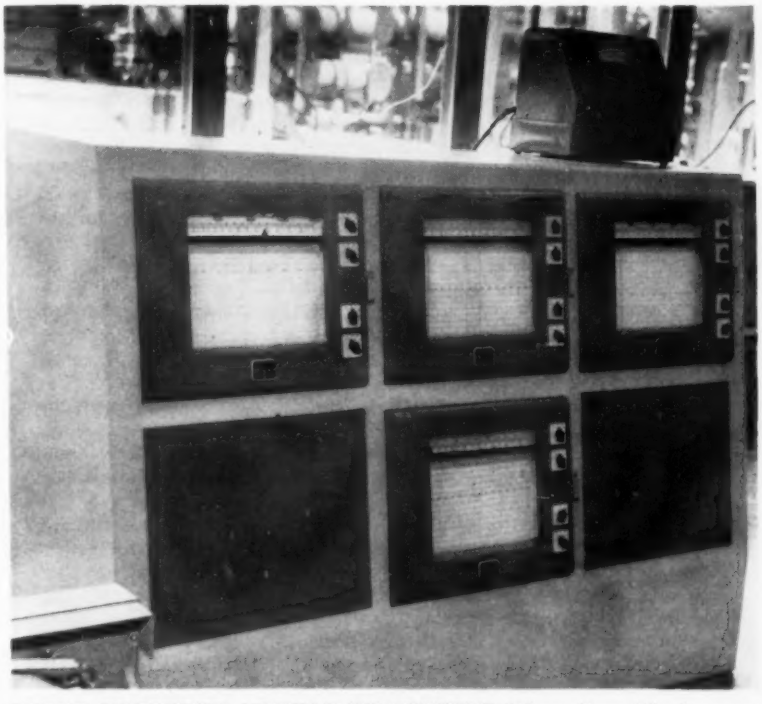
The information-systems, with its associated paper tape punch (for a computer) and trend recorders, continuously and automatically gives an up-to-the-minute picture of the unit.

Output data from the logger is typed on log sheets once an hour. Space is provided for from 72 to 216 points for each of 24 hourly logs plus 12 on-demand logs. Logging is at the rate of about one point per second.

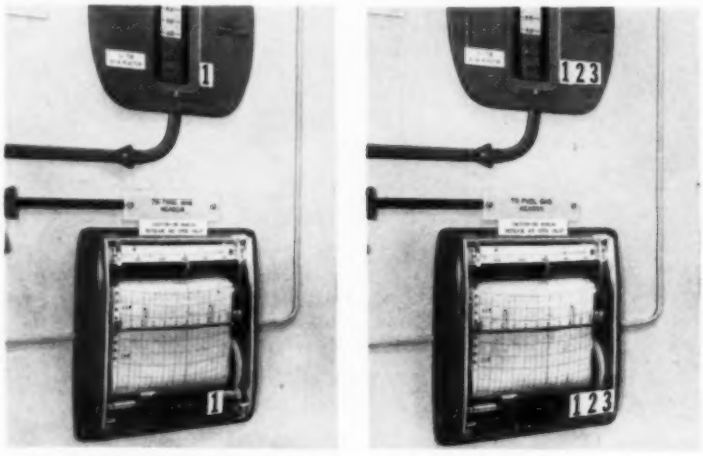
Each point connected to the information-system has predetermined operating limits, which can be adjusted to the desired high and low values for the process. Whenever a point is outside of these preset limits, it is logged in red on the log sheet. Upon return to normal, the point is logged in black. In addition to logging off-normal points during the hourly and demand readouts, the system scans for off-normal values at the rate of five points per second. These values are typed in a special section of the log sheet.

Once a day, a summary of unit

OUTPUT DATA FROM ALL CONTROL POINTS is logged automatically on an hourly interval basis. Off-normal values are scanned and shown in red



TREND RECORDER AT REAR OF CONSOLE follows "trends" of process variables. TelAutograph on top relays lab test data to control room



STAGES OF COMMISSIONING for instruments shown by numbered stickers. Instruments in left photo have had visual inspection only: those at right are completely commissioned

Fool-proof Instrument Check-out

IT'S easy to miss an instrument when commissioning an entire new refinery the size of Tidewater's, unless special care is taken.

Panellit Service Corp. developed a very simple, yet effective, way of letting its people, as well as Tidewater's process unit operators, know when instrumentation commissioning was complete on any specific unit. Adhesive stickers, labeled "1," "2" and "3" are placed on checked instruments as soon as the corresponding part of the three-step commissioning checkout is completed, as shown in the photographs.

After instrument installation and checkout by C. F. Braun & Co., Panellit started this complete three-stage commissioning procedure:

1—Visual inspection: All instruments and devices were inspected visually to assure that they were in the correct location. Visual inspection was also for damage to parts and removal of shipping stops or packing material. A check was made against design specifications for all control and measurement devices for conformance to size, operating range, and completeness of installation. At the completion of this stage of commissioning, "1" adhesive labels were placed on the checked instruments.

2 — Instrument activation and calibration: Each field-mounted transmitting device associated with a remote receiver was activated to assure continuity. Each panel-mounted device associated with a field-mounted controller was activated to assure continuity. All transmitters, level controls, control valves, thermocouples and essential pressure instruments were checked against a suitable standard to check accuracy of calibration. After this check, "2" labels were attached to the instruments and devices.

3—Sequential loop checkout: The entire instrument control system was actuated by individual loops. After calibration of all field-mounted and panel instruments (Stages 1 and 2), each complete control system loop was operated to simulate actual onstream operation.

As a final check, both by Panellit personnel and Tidewater operators, any instrument or instrumentation device having all three stickers has been completely commissioned.

Acknowledgement is made to the following for their helpful assistance in providing information for this article: J. McDonald, assistant manager, Delaware refinery, Tidewater Oil Co.; and F. Webb Willis, instrument superintendent, and Neil M. Blair, vice president, Panellit Service Corp.

operation is logged in the accounting section of the log sheet. This summary shows daily averages of critical temperatures, pressures, and daily totals of important flows.

The scanning ability of the unit was one of the major justifications for installing the information-system. Each point is identified on a jack panel in the center of the operating console. The appropriate plug is selected to connect any single point to a digital indicator.

Tidewater and Braun worked closely with Panellit on the design of the information-systems equipment. This close cooperation was needed, for while the instrument manufacturer can design equipment to meet almost any signal requirement, he does not have first hand information on the exact operating requirements, variables, and ranges.

Also, Tidewater reports advantages and savings in having the same company do both the information-system and the graphic panel installation. This was especially true during initial design stages when numerous changes in plans were made.

Computer tapes: The information-system, as mentioned before, codes its output data on a punched tape. The punched information is a daily summary of unit performance, giving the same totals and averages as typed in the accounting section of the log sheet.

Tapes from all the information systems are sent to a central data processing facility. Thus, in a matter of minutes, an accurate, plantwide report will summarize refinery operations for the preceding 24 hours, showing averages for important temperatures and pressures, feedstocks and utilities used by each unit, and the products that are made.

A future possible use for the punched tapes is to feed data to technical process people to check quickly the unit operations and flows, and to send information to management for study of products, crudes, markets, and other items needed for management decisions.

Trend recorders: Back of each logger-scanner console are the trend recorders. These are standard, but uncalibrated roll-sheet recorders. Their purpose is to let the operator study the continuous "trend" of any process variable.

Control points are connected to the trend recorders (from one to four points for each recorder) by using

the jack panel on the control console.

When the operator needs exact numerical values for the variable shown on the trend recorder, he must refer to the digital-indicator-scanner, or to the typed log sheets.

Instruments were standardized

Most of the instruments at the refinery were standardized by type. Although a number of manufacturers were represented, only one manufacturer was chosen for a specific item of equipment. This standardization helped get the refinery onstream, cut stores inventories, and will help maintenance and repair.

Some examples of instrument standardization are Taylor Transaire dp transmitters, Barton meters with Taylor transmission, Ashcroft gages and Consolidated relief valves, Fisher control valves and level controls, and Foxboro panel instruments.

In the future, further competitive bidding for replacements might change the degree of standardization to some extent.

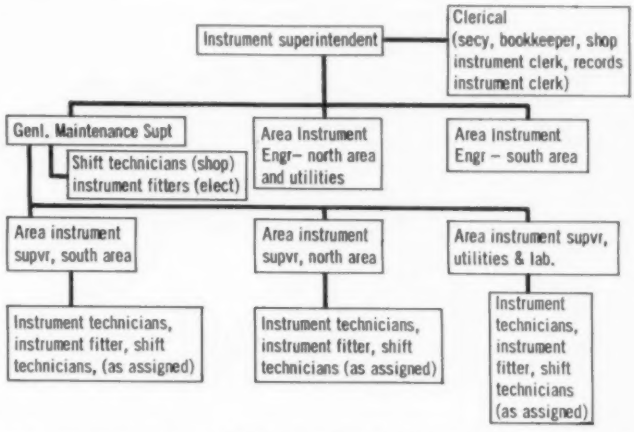
There appears to be a trend toward fewer instruments. Tidewater settled on the policy of eliminating many instruments, using some indicating rather than recording instruments, and increasing the use of miniature instruments. By doing this, the control boards were simplified, with the final board averaging about 25% less than would have been the case otherwise. Also, some instruments were eliminated by embodying their functions directly within the information-systems.

This trend, away from a multiplicity of instruments, suggests that future control instruments will combine data logging and "go-no go" signals, with a minimum of dials and recorders.

The instrumentation at the Delaware Refinery was engineered, designed and installed by C. F. Braun & Co.

Tidewater feels grateful to the many oil companies who shared their experience, attitudes, and backgrounds with Tidewater during the planning stage for the instrumentation system.

Acknowledgement is made to the following for their helpful assistance in providing information for this article: J. McDonald, assistant manager, and S. E. Roth, instrumentation coordinator, Delaware Refinery, Tidewater Oil Co.; and W. C. Gardner and J. E. Leary, chemical engineers, C. F. Braun & Co.


Instrument superintendent
Clerical (secy, bookkeeper, shop instrument clerk, records instrument clerk)
Genl. Maintenance Supt
Shift technicians (shop) instrument fitters (elect)
Area Instrument Engr– north area and utilities
Area Instrument Engr – south area
Area instrument supvr, south area
Area instrument supvr, north area
Area instrument supvr, utilities & lab.
Instrument technicians, instrument fitter, shift technicians, (as assigned)
Instrument technicians, instrument fitter, shift technicians (as assigned)
Instrument technicians, instrument fitter, shift technicians (as assigned)

ORGANIZATION CHART for Panellit Service Corp. instrument maintenance contract operations at Tidewater refinery

Instruments Maintained by Contract

TIDEWATER'S Delaware refinery boasts the first fully refinery-wide instrument maintenance contract in this country. The contract was signed with Panellit, Inc. in the summer of 1956. Panellit Service Corp., a subsidiary of Panellit, Inc., was formed expressly for this purpose.

Finding a company able and willing to maintain all refinery instruments on a contract basis was not simple.

Panellit already had a contract with Tidewater to maintain the Panellit-made information-systems. The next step, contract maintenance of all instruments, resulted from conversations between Panellit and Tidewater.

Since, by the summer of 1956, startup for the Tidewater refinery was imminent, Panellit had to move fast to form its Service Corp., assemble personnel, and commission the instrumentation prior to startup.

Tidewater furnishes materials, space, equipment, transportation, and other needed items and services. In return, Panellit does the work requested by Tidewater, and in the manner requested.

Most of Panellit's liaison with Tidewater is through Tidewater's instruments coordinator, who in turn reports to Tidewater's superintendent of maintenance and construction.

The Panellit organization at Tidewater has about 40 people, 25 of whom are technicians (see organization chart). They give 24-hour maintenance coverage to Tidewater, using a skeleton crew for off-hours and weekends.

The two instrument engineers shown on Panellit's organization chart are not engaged directly in maintaining the instruments. Their duties are to make studies of proposed changes, do design, make proposals for improved operation, optimize, improve, and make other recommendations to be submitted to the Tidewater Instruments Coordinator.

The contract with Panellit Service Corp. is for maintenance of all refinery instruments except the Panellit-made information-systems. The parent, Panellit, Inc., maintains the latter equipment.

Preventive maintenance histories of instrumentation will be recorded on cards which Panellit can adapt easily to IBM machine operation. If the IBM machine is not used, the cards can be used as a regular filing system, with color coding to show the frequency of maintenance needed.

One result of Panellit's decision to undertake maintenance for Tidewater's Delaware refinery instruments is a plan to make this service available to other refineries, regardless of the type or make of instruments involved.

TIDEWATER SERVICES

". . . list of metals

Table 1—How metals were chosen for the Tidewater refinery

In this equipment:	To combat these conditions:	These metals were used:
Crude unit	High temperature	5 to 9% Cr - ½% Mo
	High sulfur crude	Type 316 stainless: 5 to 9% Cr alloy
	HCl	Monel
	H_2S	Inconel
	Napthenic acid	Type 316 stainless
Fluid Coker	High temperature	Type 316 stainless
	High sulfur crude	Type 316 stainless
	HCl	Monel
	H_2S	18% Cr - 8% Ni clad
Fluid Cracker	High temperature	12% chrome steel
	High sulfur stocks	12% chrome steel
Gas recovery unit	No special corrosion except DEA	Carbon steel Type 347 stainless
Reformer	High temperature	1% Cr - ½% Mo
	H_2-hydrocarbon mixtures	1% Cr - ½% Mo
	Chlorides	K-monel
Poly plant	No special corrosion except strong H_2SO_4 valves	Carbon steel Aloyco 20
Alkylation	No special corrosion except H_2SO_4 valves	Carbon steel Aloyco 20
	and H_2SO_4 pumps	29% Ni-20% Cr
Sulfur plant	No special corrosion	Carbon steel
Unifiner	High pressure H_2	7 to 12% Cr.
	High temperature H_2S-H_2	7 to 12% Cr.
	Ammonium sulfides, chlorides	Monel clad
Hydrogen plant	High temp. H_2	Incoloy; 1% Cr-½% Mo; 25% Cr-20% Ni (in furnace tubes)
	CO_2 - condensate	Aluminum; 18% Cro-8% Ni
	Hot MEA	18% Cr-8% Ni
Udex	No special corrosion	Carbon steel
Cooling-water system	Salt content in:	
	Main pumps	29% Cr-9% Ni
	Valves, above 110°F.	Ni-resist
	Piping, 2" and smaller	Galvanized steel
	Piping, 3" and larger	Cement lined
	Tubesheets	Naval rolled brass
	Tubes	70% Cu-30% N
	Shell	Steel
Water-treatment plant	No special corrosion except caustic	Carbon steel Nickel

METALLURGY

By W. A. BUSSARD
Assistant Editor
PETROLEUM PROCESSING

DESIGNING a refinery to process the highest sulfur crudes known demands careful selection of metals. And the problem is not simplified knowing that brackish water, occasionally as salty as sea water, will be used for cooling.

These were the main problems confronting Tidewater in selecting the metals for the equipment at their new Delaware refinery. The final decision on what metals to select was not easy, and was reached only after consultation by C. F. Braun metallurgists, experienced Tidewater operators, manufacturers and the engineers of process licensors. A survey of other East Coast and Gulf Coast refineries processing similar high-sulfur crudes also helped decide which metals to select.

Knowing that the processing of heavy Wafra crude—with sulfur content over 4%—would cause corrosion problems, Tidewater had the choice of three design philosophies in selecting alloys:

1—Use the cheapest materials initially, and replace with better alloys as operating experience developed,

2—Use the most expensive alloys wherever any suspicion of corrosion existed, or

3—Use the least expensive alloys or carbon steels for replaceable parts, and higher alloys for the large and expensive-to-repair units.

The choice was the third approach.

Of course, corrosion by crude components was not the only consideration in selecting metals. The high process temperatures encountered in units like the cat cracker and fluid coker, plus the erosive properties of catalysts and fluid coke, dictated the choice of some materials. In the cat cracker risers, stellite is used for combatting erosion, and in the fluid coke lines to the power station, a monolithic liner is depended upon to solve another erosion problem.

Other design problems also had to be considered in selecting the right metals, especially in a refinery which has no duplicate processing facilities. Naphthenic acid from Venezuelan crudes, corrosive chlorides, hydrogen sulfide-hydrogen mixtures, diethanol

reads like a textbook on alloys"

Table 2—How metals were selected for piping

To combat these corrosive agents	at these temperatures	Piping was made of these metals
Sulfur	below 450°F	Carbon steel
	450 to 600°F	Carbon steel plus 1 Schedule number in thickness. 5% Cr where pipe difficult to replace
	600 to 700°F	7% Cr alloy
	700°F and up	9% Cr alloy
Chlorides	below 300°F	Monel
Hydrogen sulfide	above 550°F	7% Cr alloy
DEA solution plus high hydrogen sulfide	—	Type 316 stainless
Carbon dioxide	—	Stainless steel
Hydrogen	above 450°F	1% Cr - ½% Mo
	up to 1800°F	Incoloy
Cooling water	—	Steel, cement lined - above ground Concrete — large underground
High temperature graphitization	up to 800°F	Carbon steel (ASTM A-53)
	800 to 900°F	Carbon steel with ½ Mo
	900 to 1050°F	Carbon steel with 1½% Mo, 1% Cr

imine solution from the DEA unit, CO_2 from the hydrogen plant, and hydrogen itself—all of these had to be considered.

Almost every corrosion and high temperature problem known to the petroleum industry was encountered. As a result, the list of alloys used in the process units reads like a textbook on alloy metallurgy.

To combat these expected conditions, the choice of metals followed the general pattern described as follows:

High sulfur content streams—steel, with a chromium content that increased with the temperature.

Naphthenic acid—Type 316 stainless steel for critical spots, chrome alloys for replaceable pieces of equipment.

Chloride in crude oil—monel.

Hydrogen-hydrogen sulfide mixtures—12% chrome alloys, and 18% Ni-8% Cr alloys.

Diethanolamine solution—Type 316 and Type 317 stainless steel on large equipment; bi-metal for water cooling exchangers.

Carbon dioxide—aluminum.

Hydrogen — chrome-moly alloys, with chrome content increasing as the temperature and partial pressure of hydrogen increased; for over 1200°F, Incoloy and Type 310 stainless steel.

High temperature—up to 800°F, carbon steel. Between 800 and 900°F, carbon steel with 0.5% Mo. Over 900° F, carbon steel with 0.5% Mo and 0.5% Cr.

Salt water—Cr-Ni alloys, Cu-Ni alloys, and concrete linings.

A complete breakdown of the materials used is given in the accompanying tables.

Where corrosion and erosion were acute problems, the vessels or piping were not always of solid alloys. In many cases clad steels were used. For example, in the fluid coking unit several types of clad steels were used. In the reactor scrubber—23 ft in diameter and 90 ft high—Type 316 stainless-clad, in thicknesses from ½ to 1¼-in. was used to resist sulfur compounds and naphthenic acids. The fractionator tower of the same unit uses Monel-clad steel in the upper section and 12-Cr stainless-clad in the lower section to resist mineral acids and sulfur attack. Thickness of the cladding here varies from 7/16 to 9/16 in.

Similar construction was used in the heat-exchangers that are exposed to brackish water. Tubesheets are naval brass, while floating head covers exposed to this condition are protected with aluminum bronze overlays, deposited with inert-gas metal-arc welding equipment. Barrels and nozzles of the channels are fabricated from solid aluminum bronze plate, a departure from normal practice. The flanges are of steel. Estimates show that reduced maintenance and continuity of operation will return this extra investment.

An interesting application was the use of Incoloy, a high-temperature alloy, in a transfer line in the hydrogen plant. The 16-in. line between the hydrogen reformer furnaces and the converters is designed to operate at 1,450°F and 150 psig. This line was fabricated from rolled and welded plate, and then given a heat treatment to produce a coarse-grain structure. This gave an allowable design stress of 2,700 psi at 1,450°F as compared to 1,550 psi for Type 316 stainless steel. Thus, the higher allowable design-stress more than offset the price differential between the two metals. Also, the Incolov is not subject to the formation of detrimental phase changes (such as the sigma phase) in the temperature region of 1,200 to 1,450°F.

The selection of metals for piping, valves, fittings and pumps followed pretty closely the material selected for the process vessels. Most of the piping was ASTM A-53 carbon steel, wherever the operating temperature was below 775°F. Monel and gunite linings were employed in some special cases.

In all, more than a million pounds of nickel in alloys, and some 2,000 tons of non-ferrous metals went into the construction of the refinery.

The helpful assistance of the following is acknowledged in the preparation of this article: J. J. Mack, chief engineer, Delaware Refinery; and G. R. Prescott, metallurgical engineer, C. F. Braun & Co.

TIDEWATER SERVICES

"... all equipment

DESIGN FOR MAINTENANCE

MOST older, and many newer refineries are designed to meet process requirements and have safe structures—but few are designed for ease of maintenance. Tidewater decided to "design for maintenance" as well as construction and operations.

Because Braun had previous experience in reducing maintenance costs at refineries, Tidewater and Braun jointly prepared a preliminary work specification entitled, "Plant Layout for Operation and Maintenance." Some typical examples from this Specification, with illustrations showing how the principles were actually applied, are shown by the photographs on these pages.

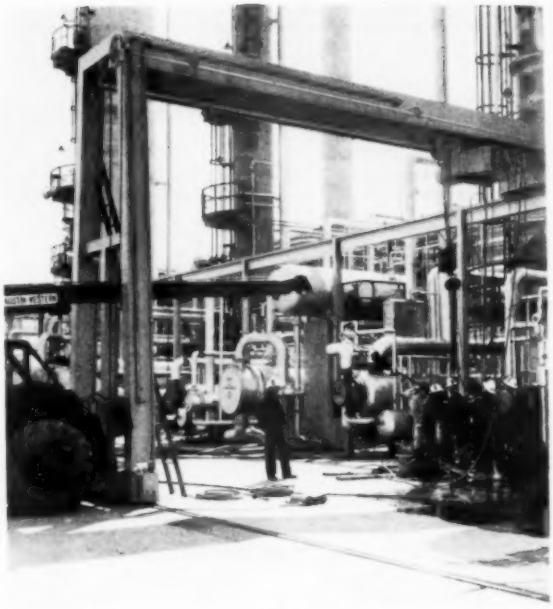
Other features of "Plant Layout for Operation and Maintenance," not shown specifically in photographs here, include:

Access roads that are provided on all four sides of every operating area, and generously designed accessways to the process units that are provided inside of the operating areas. The minimum width of an on-plot accessway is thirty feet, and where at all possible, there are no accessway deadends that would force mobile equipment to back out of the area. There is ample room to maneuver mobile equipment within the operating area.

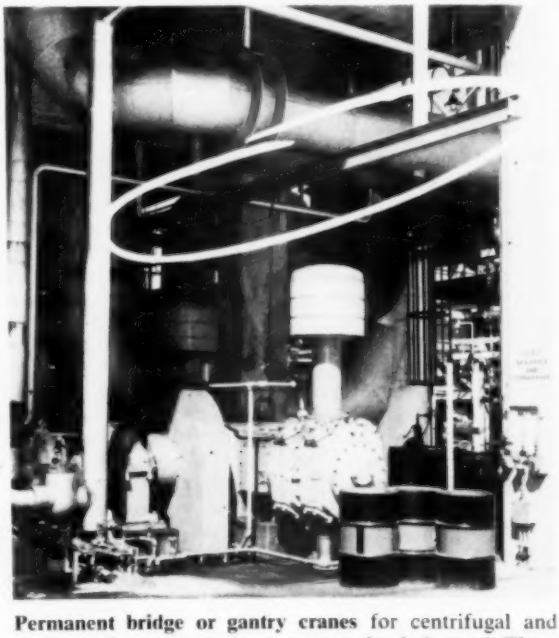
Facilities to lower equipment to the ground are supplied in all cases where an item weighs more than 150 lb. and the item cannot be reached for handling by a mobile crane.

Pumps are grouped in orderly rows, and when possible, located outside of buildings for safety and ease of maintenance. Pumps are not located under pipeways, walkways, or other overhead structures, thus allowing the pumps to be approached and handled by mobile cranes. The pumps are located adjacent to accessways, with clearance around them to allow easy maintenance and repair handling by mobile equipment.

Tidewater hopes that it will be able to adhere to its "design for maintenance" philosophy, even in the face of future process expansions and new equipment additions that may come.

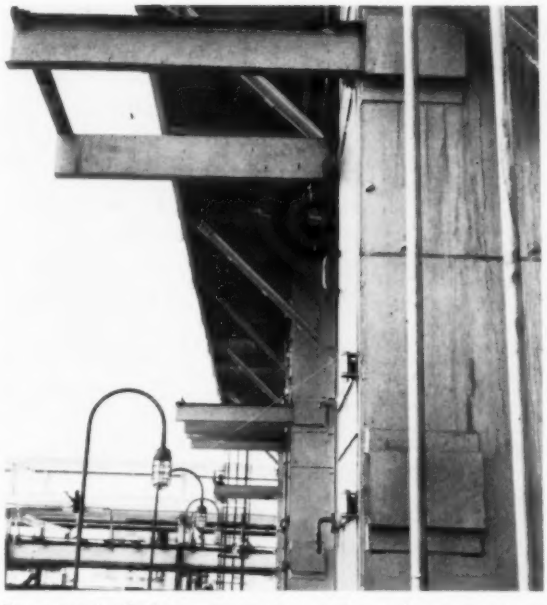


Elevated structures are eliminated by mounting condensers and heat exchangers at grade level, process permitting. They are located near the plot edge with the bundle oriented so that it can be pulled and lowered without turning. Grade-mounted exchangers and condensers are grouped for handling by a single gantry crane. Elevated equipment has a platform at each end, an access stairway, an escape ladder, and built-in trolleys.

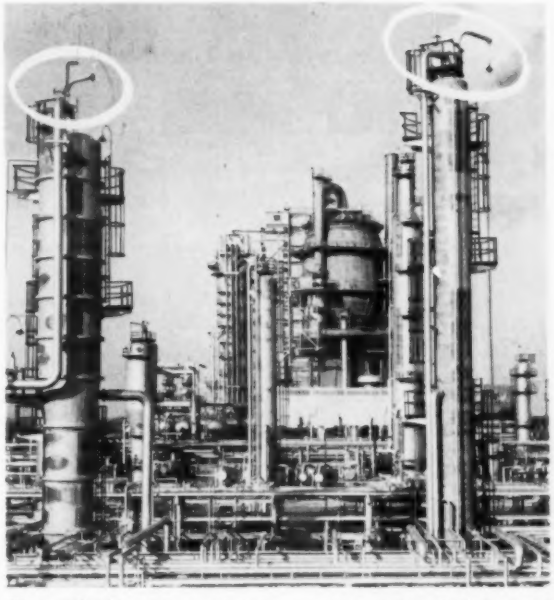


Permanent bridge or gantry cranes for centrifugal and reciprocating compressors are conveniently located. These conveniently located cranes speed maintenance work and disassembly (see circled area in above photograph of a compressor installation).

was located for easy access"



Permanent platform supports are located at all return bends on furnaces (shown above) to give added help to maintenance. Planking laid across these supports gives firm and convenient working space for maintaining the furnaces. Furnaces are located near the plot edge for safety and easy access from off-plot roads. Tube pulling areas are provided on-plot, and all furnaces have trolley beams to handle header doors and tube rolling tools.



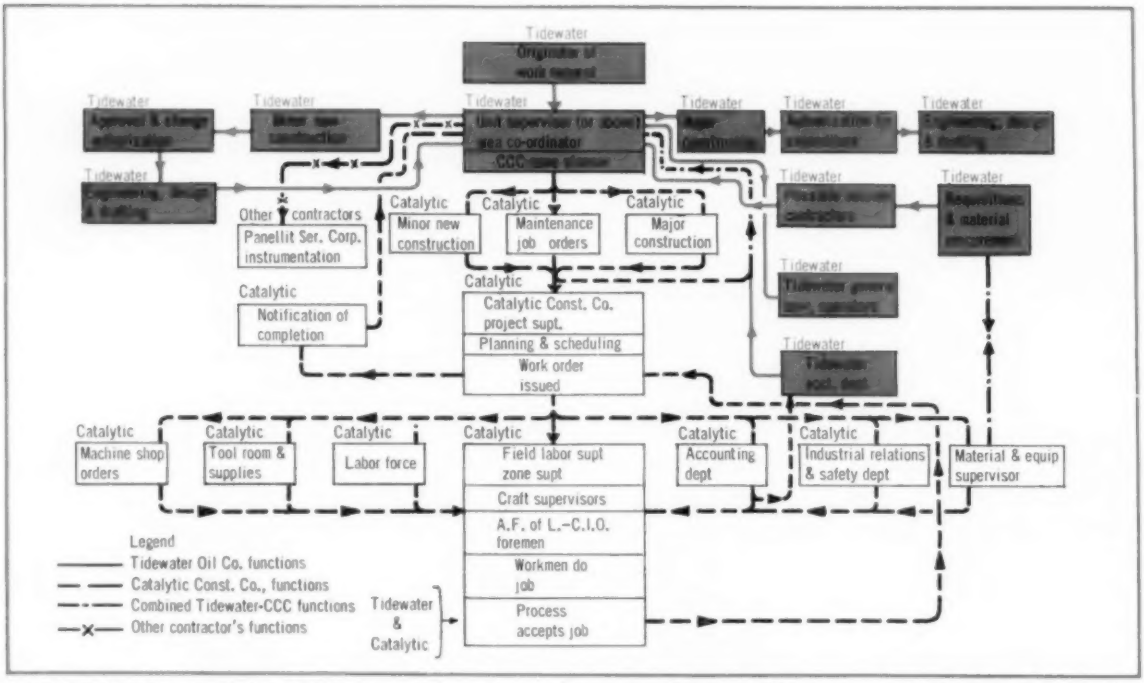
Tower davits on top of columns (shown by circled areas above) allow easy handling of trays, relief valves, and other heavy, elevated items. Platforms and manholes are oriented on the tower structure to allow bubble caps and trays to be lowered with no dodging of intervening obstructions. Sufficient access room is provided to give mobile equipment room to handle the items lowered by the tower davit. Accessways are wide and plentiful.

Platforms galore instead of the usual fixed or portable ladders, are supplied for the following typical installations: level controls, equipment more than ten feet above grade, manholes and handholes, cleanout fittings, control and relief valves and flowmeters.

Stairways are preferred over ladders for safety. A worker can carry small items up stairs, but with a ladder, two men are required. Any instrument that must be checked regularly is served by a stairway. Because stairs are easier to climb, operators are encouraged to inspect upper levels.

TIDEWATER SERVICES

"... maintenance



INFORMATION FLOW CHART for work orders and requests between Tidewater and Catalytic Construction's contract maintenance organization

MAINTENANCE

By ROBERT L. DAVIDSON
Associate Editor
PETROLEUM PROCESSING

THE very largeness of the process units at Tidewater's Delaware refinery spurred the use of contract maintenance.

Fundamentally, the refinery is simple. There are less than a dozen major process units. This small number of units and the convenient physical layout of the equipment reduce routine maintenance jobs to a minimum. However, when turnaround time rolls around, maintenance manpower requirements skyrocket.

This combination of limited routine maintenance with immense turnaround loads means that a staff sufficiently large to handle turnarounds would spend a great portion of the year doing "made work."

Facing these problems, Tidewater decided that the most practical solution was to have all mechanical maintenance work done by a contractor, Catalytic Construction Co., which was in a position to vary its payroll to meet fluctuating labor needs. Catalytic is no newcomer to contract maintenance of refineries, having had experience with other refineries—notably Sun Oil Co., Ltd., at Sarnia, Ontario.

Maintenance organization

Tidewater has only a small management force in its maintenance group, consisting of the superintendent of maintenance and construction directly over coordinators for the North Area, South Area, Utilities, Instruments, and Electrical.

The Tidewater superintendent of maintenance and construction, and his coordinators work directly with their counterparts in the Catalytic maintenance organization.

Catalytic's maintenance organization has a project manager, a general field supervisor, three area supervisors, a planning and coordination group, as well as a staff of craft supervisors.

Tidewater has a small force of general service operators on a three-shift basis to assist unit operators in maintaining continuity of operations of the various units by providing assistance in the varied operating problems which arise. These include miscellaneous emergency and routine services, dockside services for tankers and barges, and other duties such as fire fighting.

To handle the maintenance of the refinery's mechanical equipment, Catalytic anticipates a routine manpower level of around 200. This figure is still tentative. More experience in this particular refinery is needed to know what future needs will be. Peak manpower needs during turnarounds may be in the vicinity of 500 men.

Duties performed by Catalytic, in addition to preventive, routine, and turnaround maintenance on mechanical equipment, include operation of the machine, pipe, boiler, automotive, sheet metal, and steel fabrication shops for Tidewater.

Tidewater controls all equipment and specifications, buys all materials, and owns or rents directly all tools, equipment, shops and other facilities. In addition, Tidewater handles any sub-contracts needed, such as for chan-

done by a contractor—Catalytic"

Table 1—Typical turnaround schedule for Tidewater Delaware refinery

Week*	Cracker	Gas plant	Crude unit	Reformer	Udex	Poly Unit	Coker	Solutizer	Alky	Sulfur recovery
1	SD	SD	O	O	O	SD	O	O	SD	SD
2	SD	O	O	O	O	O	O	O	SD	O
3	SD	O	O	O	O	O	O	O	O	O
4	O	O	O	O	O	O	SD	O	O	O
5	O	O	SD	O	O	O	SD	SD	O	O
6	O	O	SD	O	O	O	SD	SD	O	O
7	O	O	SD	O	O	O	SD	SD	O	O
8	O†	O	O†	SD**	SD	O†	O†	O†	O	O
9	O†	O	O†	O†	O†	O†	O†	O†	O†	O†
10-52	O†	O†	O†	O†	O†	O†	O†	O†	O†	O†

*Starting first week of March.

**Includes train No. 1 desulfurizer (for cat reformer). Trains 2-4 shutdown during 9th week (kerosine, No. 2 fuel oil, etc.)

NOTE: SD means shutdown for turnaround. O means operating at reduced throughput. O† means operating at full capacity. The above turnaround sheet is typical for one type of crude only—will vary for other crudes and operating cases.

nel dredging. Catalytic's maintenance team is a service organization.

Tidewater decides what maintenance work will be done, when it will be done, and how many people Catalytic can hire to do the job. Tidewater sets the work priorities and schedules of when the job is needed.

Catalytic arranges the planning and scheduling, and supplies the manpower and experienced maintenance supervision. The accompanying information flow chart illustrates the liaison and working arrangement.

The turnaround season

Most of the turnaround work is scheduled for early spring, starting the first of March. By the end of May, all turnarounds should be completed until the next year's session.

The cat cracker, gas plant, polymerization and alkylation units, and sulfur recovery unit are the first to be shutdown for turnaround (see the typical turnaround schedule), followed by the Fluid Coker, crude unit, solutizer, Houdriformer and Udex unit.

The first turnaround of a major unit was successfully completed in mid-April of this year, at which time Catalytic's work force was built up to about 500 men for a period of about 8 days.

Maintenance shops

Tidewater purposely has a minimum of facilities and equipment in its shop. Tidewater adopted the basic philosophy that they wanted a minimum investment in permanent facilities and personnel so that a maximum rate could be realized on the investment in the process units. However, with an emphasis of maximum throughput in the large process units, adequate facilities had to be established within the plant for limited repair work needed for emergency shutdowns.

For most major repair and replacement projects, there are sufficient mechanical spares and time so that major work of this type could be contracted to large shops outside the refinery.

The selection of equipment for the maintenance shops, therefore, was made on the basis that under reasonable conditions, the equipment would be operated continually enough to make its depreciated cost competitive with outside shops for the work done. Any excess cost over that of independent shops in the area could be accounted to necessary operating expenses. (please turn page.)

Standardization Cuts Inventories

TIDEWATER'S new refinery was planned for a high degree of equipment standardization. The results are reduced stores inventories and easier maintenance.

Equipment, selected initially on the basis of competitive bidding, was bought with the successful bidder supplying all (or most) of a specific item. For example, most pumps were furnished by Pacific, most electric motors and switch gear by Allis Chalmers, three types of steam turbine drives by Elliott, and steam traps by Yarway.

Another example of standardization is that essentially all heat exchangers are by Braun, and are 20 ft long with ¾-in. tubing. The tube-field layout of all exchangers is the same. The range of exchanger sizes is from 15 to 48-in. diameter (with intermediate sizes of 18, 20, 24, 28, 32, 36, 40, and 44 in.) Thus, all heat exchanger requirements are met with only 10 standard sizes.

The 400 heat exchangers in the refinery, representing several pressure classifications, are standardized so that only 19 different tubebundles are required for spares.

Tidewater hopes to hold as many of the advantages of this standardization as possible. However, in the future, as replacements are needed or as expansions are made, the original supplier of an item might not be the lowest, and competitive bidding will result. In such a case, a new successful bidder will be given specifications to make equipment fit existing installations with a minimum of modification.

Maintenance (continued)

Catalytic finds no difficulty in getting good craft labor for short periods of time during process unit turnarounds. The pay is on the construction wage scale (less certain fringe benefits).

Although actual hourly rates for a maintenance contractor in accordance with construction trades practices are higher than that of a refinery's work force, the total manhour costs for contract labor are lower because of the fringe benefits allowed for the industrial plant employe.

Catalytic estimates that the local labor pool in Wilmington and surrounding areas is in excess of 6000 men. In addition, craftsmen are attracted from Philadelphia, and some come from as far away as central Pennsylvania.

One of the secrets of Catalytic's success in getting needed manpower of the desired quality, often on very short notice, is a clearly understood working agreement with craft unions. Catalytic has a single contract which was negotiated with the presidents of fourteen American Federation of Labor International Craft Unions. Though this was a special project developed to meet the needs of contract maintenance for Tidewater's Delaware refinery, this same arrangement applies over the entire area under the jurisdiction of these unions, and is available for contract maintenance of other plants on a basis similar as for Tidewater.

In operation, whenever Catalytic needs more craftsmen, the unions arrange for the men. Though this contract has been in operation slightly under a year, Catalytic has found it very satisfactory.

The contract between Catalytic and the Unions was negotiated to fit refinery maintenance needs. One of the important conditions allows the use of mixed crews. In emergency cases where immediate attention is needed, any mechanic available at the time is permitted to do the needed work.

Other agreements by the union included elimination of travel time and expenses; time-and-one-half for overtime instead of double time; provisions for working three shifts a day, seven days a week on a long term basis without premium pay for working Saturdays and Sundays as part of a regular shift schedule.

Acknowledgement is made of the helpful assistance provided by the following in supplying information for this article: J. J. Mack, chief engineer, J. McDonald, assistant manager, and A. Dundas, engineer, of Tidewater Oil Co., Delaware refinery; and J. Hammond, project supt., at refinery, and A. I. McCone, asst. to president, of Catalytic Construction Co.

Automation Helps Stores Operations

STORES AT TIDEWATER, showing IBM machine for controlling inventory

"AUTOMATIC" stores—inventory control and requisitioning—is the goal at Tidewater's Delaware refinery. The stores department is working toward inventory control with IBM card machine. A refinery catalogue is being assembled to list 14,000 to 16,000 items carried in stores (including some items not yet carried, but listed now so that there will be a number available in the catalogue). The catalogue will have illustrations, as well as descriptions and pertinent parts numbers, and will be distributed to all Area Coordinators and Catalytic Construction Co. supervisors.

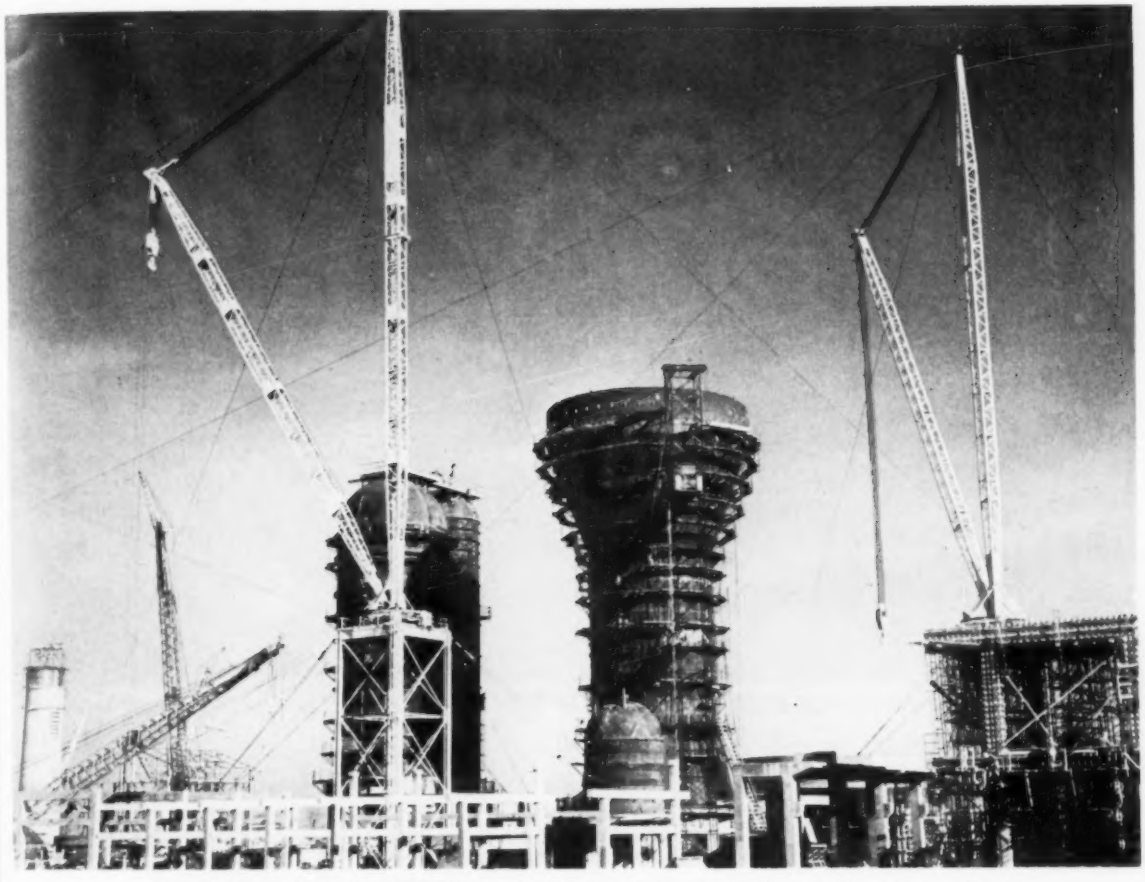
An IBM machine is also being used for mechanical requisitioning of stores materials. To order an item, a regular requisition is prepared, sent to accounting, and a punched card made from it. The card is fed to the IBM card machine, which in turn types a preliminary purchase order for any item stocked below a predetermined level (computed to bring the inventory up to a predetermined maximum level). This preliminary purchase order then goes to the purchasing department, which in turn writes a final order slip for purchase from an outside vendor.

Though seemingly simple, the automatic system is not "foolproof." Great care is needed to assure that the predetermined minimum and maximum levels programmed into the IBM machine are realistic with current needs.

Tidewater's purchasing department hopes that some day automatic requisition forms will be commonplace enough so that the IBM-printed form can be sent directly to the vendor, without the need for retyping the order on a conventional order form.

TIDEWATER PLANT & PEOPLE

"jumbo guy-derricks"



TOWERING GUY DERRICKS dominated the Delaware skyline during construction

CONSTRUCTION

By W. A. BUSSARD
Assistant Editor
PETROLEUM PROCESSING

CREATING the world's largest initial refining capacity in the shortest time on record—and doing it with an outstanding safety record—takes more than the traditional men, materials and methods. It also requires a terrific amount of planning, follow-up and cooperation.

All of these characterized the construction of Tidewater's new Delaware refinery by C. F. Braun & Co.

Perhaps one of the most remarkable things which contributed to a successful construction job was the good labor-relations which extended over the complete construction period. With craftsmen from 20 A. F. of L. Unions putting in a total of 20-million manhours, lost time causes from all sources were less than 0.03%. And the lost time that did occur stemmed largely from an area-wide wage negotiation that affected one craft in that entire area of Delaware, not just those at the refinery.

During the over-two-year life of the job, there were 33 controversial work assignments involving jurisdictional disputes. All but two were settled without lost time. These two disputes, reported to the National Joint Board, represented a total loss time of 2,500 manhours, or about 0.01% of total time worked.

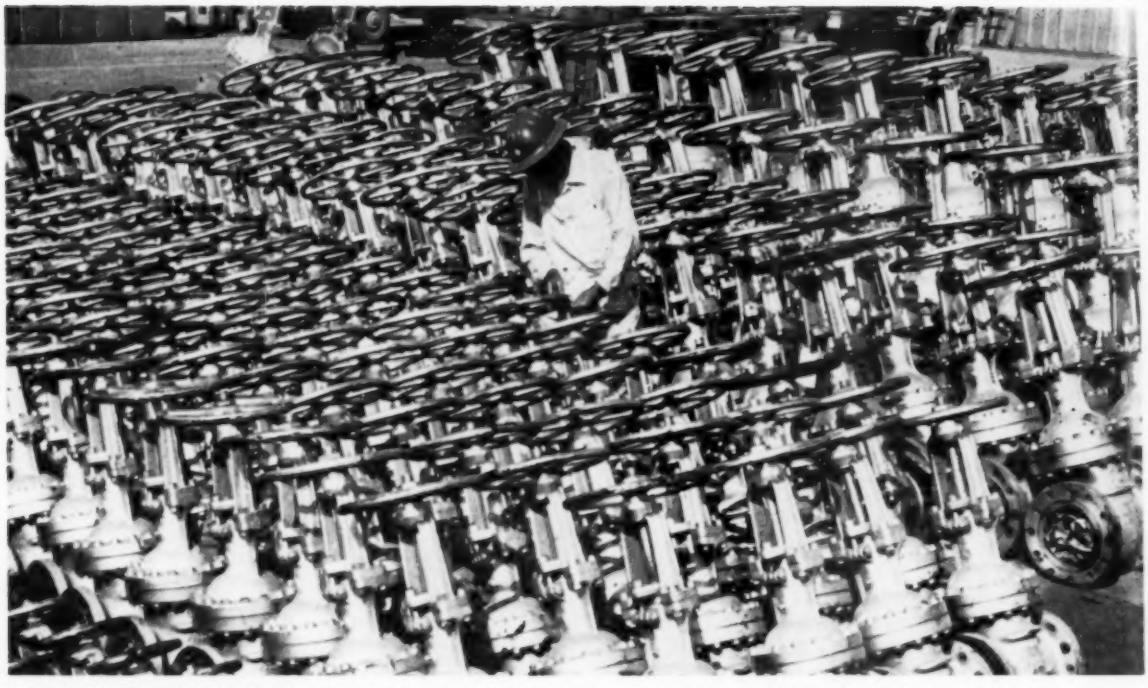
Three reasons seem to explain such an unusual construction labor record:

1—A project-long agreement with the principal international labor unions, negotiated before the project began.

2—A genuine desire of the labor unions to do a good job.

3—Project-long residence at the refinery site of C. F. Braun labor relations experts capable of keeping an eye on every-day operations and solving problems before disputes arose.

Careful planning before and during the job was evident in the job of procuring material during the entire period of construction. It was essential that the vast amount of material needed—over 100-million dollars worth of equipment—arrive at the jobsite in proper order. Otherwise it would have been impossible to get the power station and some of the re-



ONE HUNDRED THOUSAND VALVES—of which these are a few—went into the Tidewater building project

finery units operating within eighteen months and the remainder of the refining units in two years.

Logistics planning for construction of the refinery followed this path. First, a master plan covering all phases of the work (engineering, design, procurement, fabrication, construction) was developed by project coordinators. Then, detailed schedules for each of these separate phases were drawn up. These were the guides for all material planning.

Master expediting sheets were developed every week by a four-man committee from the scheduling, purchasing, engineering and construction departments. Quick followup was made on every critical item that might delay completion, with the result that rarely were field forces help up by late deliveries.

As the materials and equipment descended upon the refinery site from all over the country, a place was scheduled for every bit of it. Well over 30,000 truckloads, thirty-five barge-loads, and 4,000 rail cars brought in the equipment summarized in the table. During this period of two years, a fifty-man staff-group of engineers, purchasers, expediters, and coordinators devoted 200,000 man-hours to taking care of this flow of material and equipment.

Not only was the amount of material used unique, but some of the actual construction problems were also unusual. To help erect the eleven major process units, four of the world's largest guy-derricks were spotted throughout the process area. Rigging crews used these three 200-ton and one 150-ton guy-derricks primarily to put together the process vessels in the fluid coker, crude unit and cat-cracker. Nearly 70 miles of wire rope were strung and reeved for load-lines and guy-lines on these four derricks. And to reach the top of the coker unit—some 250 ft in the air—one derrick was mounted on a 135-ft steel tower, putting the top of the derrick mast 320 ft above the ground.

Handling materials in tremendous quantities also had to be done efficiently and with planning. A modern concrete batch-plant at the jobsite produced half of the concrete used, turning out 71,000 cu yd. The balance was supplied locally.

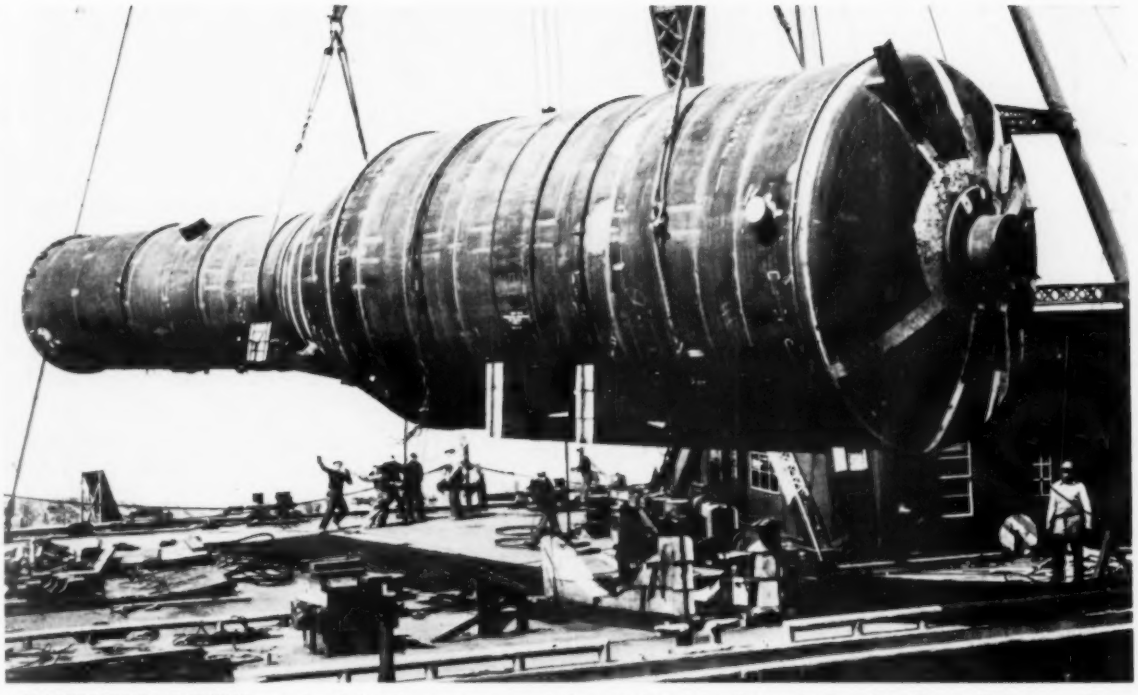
A special pipe-fabricating shop was established in the refinery maintenance shop (PP, p. 96, July '56) and turned out up to a thousand pipe spools per week. It was unmatched in capacity by any shop in the world during its brief lifetime.

To handle and erect the myriad of equipment pieces summarized in the table, a severe problem did exist in manpower recruitments. But by intensive scouring of not only the immediate Wilmington area, but also Philadelphia, New York and Baltimore, personnel recruiters managed to fill even the demands for critical crafts such as electricians and pipefitters. But pipe welders were in such short

How much equipment was installed?

Storage tanks	139*
Heat exchangers	390
Bubble columns	70
Unfired pressure vessels	240
Fired heaters	35
Pumps	620
Compressors	50
Pipe, miles	950
Valves	100,000
Electric wire & cable, miles	1,480
Fabricated structural steel, tons	9,000
Lumber & plywood, bd ft	9,500,000
Concrete, cu yd	132,000
Paving mesh, sq ft	1,400,000
Reinforcing bar, tons	5,200
Welding rod, tons	480

*representing total capacity of 7,650,000 bbl



HANDLING 75 TONS worth of fractionator—one of the tougher jobs Braun had to handle at Delaware City

supply that Braun operated a welding school at the site, training some 400 qualified pipe welders during the project.

The coming and going of 10,000 construction men per day posed additional area-wide problems that concerned the county and state governments. Every morning 4,000 automobiles converged on the job's 30-acre parking lot like a crowd going to a football game. State police were required to unsnarl traffic at highway intersections, and the state established one-way roads and set up signal lights especially to handle this crowd. It was even necessary to construct a special intersection on the highway leading from the refinery site.

When applied to the quantities of material handled during construction of this project, numbers alone do not tell the entire story. Moving 16 million cu yd of earth, placing 132,000 cu yd of concrete, and erecting 9,000 tons of structural steel do not seem impressive when listed together—for they are all so large.

But when we realize that the water system erected for cooling at the refinery is adequate to supply a Greater Philadelphia, or that the total length of wire in the light and power circuits would extend from New York to Cleveland, or that it required installation of 100,000 different valves in 950 miles of pipe before the refinery could operate—then the sheer size of the construction problems can be appreciated.

Certainly constructing a 130,000 bbl/day refinery from the ground up has many highlights, but perhaps the best one is knowing that it was all accomplished while establishing an outstanding safety record too.

Acknowledgement is made to the following for their help in providing information for this article: P. M. Terry, resident manager, J. M. Phelps, senior engineer, and L. D. Leeper, assistant manager of construction division of C. F. Braun & Co.

Construction breaks safety records

DURING construction of Tidewater's Delaware Refinery, Braun forces experienced only one fatality—a performance five times better than the national average in the construction industry. And the lost-time accident rate was 2½ times better than the national average. For these accomplishments, C. F. Braun & Co. received an award from the National Constructors Association.

The success of the safety program resulted from the work of an organized safety engineering group, which cooperated with the labor unions and was fully backed by the construction supervisors. When safety engineers noticed work hazards, construction supervisors endorsed their opinion and saw that the situation was quickly corrected. Otherwise, work was stopped until the hazard could be corrected.

Safety equipment was provided for all men and the use of it rigidly enforced. First-aid centers and equipment were available for any injuries that did occur. Every new employe received instruction in safety before reporting to work, and while on the job.

"... eight criteria"

SITE SELECTION

By VIRGIL B. GUTHRIE
Associate Editor
PETROLEUM PROCESSING

THE task of selecting a site for the new east coast refinery of Tidewater Oil Co. started early in 1954, when it was decided the refinery at Bayonne, N. J., originally acquired in 1888, was obsolete beyond redemption and entirely inadequate in capacity and acreage to serve the company's needs.

The new project involved a great deal more than just buying the property and putting up the buildings and processing units, which materialized late in 1956 in the Delaware Refinery.

Economic and engineering studies were conducted for almost a year before the location for the new refinery was picked out. These studies included:

1—Analysis of the likely growth of population in the marketing territory of Tidewater's Eastern Division, so the new plant would be strategically located to serve future as well as present markets.

2—Study of the probable crude supplies available to the company in the coming decades, so crude oil transport costs could be held as low as possible commensurate with other key factors in plant location.

3—Check on the facilities for securing crude only by water, and for transporting refined products from the refinery by pipe line, highway, water and railroad.

4—Survey of labor conditions in the areas under consideration. This included labor management relations in general, as well as the more tangible matter of the present available labor supply and housing for future labor needs.

5—Study of community relations, including particularly data on local, county and state zoning or other restrictions which might affect heavy industries coming into the territory.

6—Availability of large area of land.

7—Compliance with the Federal dispersal policy for essential industries.

8—As the choice of plant sites narrowed to certain definite areas, contour maps of the properties were studied and surface and sub-surface soil conditions checked as keys to plant design and structure foundation costs. These factors were more accurately studied after the first property options were obtained.

These studies, preliminary to the selection of a plant site, were carried on both by Tidewater and by the C. F. Braun & Co., Alhambra, Calif., the overall plant contractors. A refinery representative, traveling incognito on many occasions, visited river and bay shore lines from Providence, R. I., to Norfolk, Va. He personally checked on 30 possible plant sites.

Braun, starting in 1953, carried on technical engineering studies. It was determined that expansion and modernization of the Bayonne refinery was not economical. Various locations in the Chesapeake Bay and Delaware River territory were studied before the Delaware City site was purchased.

In the study of population trends, the territory considered was the present market of Tidewater's Eastern Division, which includes the 13 Middle Atlantic and New England states and the District of Columbia. At present 60% of the company's business is above New York City and 40% below. This would favor a new plant location in the general area of the Bayonne refinery. However, looking to future markets, the trend in population growth is greater in the states below New York.

This conclusion was supported by U. S. Dept. of Commerce data which showed that 30% of the U. S. population lives within a radius of 300 miles of Delaware. Although the region constitutes only about 6.5% of the land area of the U. S., it has about ⅓ of its purchasing power. So the weight of this study was in favor of the Delaware location.

The survey of present and future available crude supplies for the new refinery was not only important as an economic factor in plant location. It also had a definite effect on the materials going into its construction. Since Middle East and Venezuelan crude may be processed as well as domestic crude from the Gulf Coast, the crude unit at Delaware City was designed to handle any type of crude.

The study of transportation facilities showed the Delaware City location was convenient for the volume movement of products by highway, railroad and water. Modern highways skirting the property connect with expressways leading to cities in Maryland, Virginia, Pennsylvania, New Jersey, New York and New England. The Pennsylvania railroad has a six-mile spur from Porter to Delaware City which had been unused for three years. Tidewater bought the PRR dock at the Delaware River and the railroad established a station for rate-making purposes at Reybold, Del.

To provide water movement, Tidewater built a marine terminal on the Delaware River, part of the general 5000-acre refinery site, and dredged a two-mile, 40-ft deep channel from the main channel of the river.

Acknowledgement is made to R. S. Stanfield, refinery representative, Delaware Refinery, for his helpful assistance in preparing this article.

TIDEWATER PLANT & PEOPLE

"over 300 borings"

DITCHES FOR BURIED LINES exposed the sub-strata previously investigated in the soil test borings

SOIL STUDIES

By VIRGIL B. GUTHRIE
Associate Editor
PETROLEUM PROCESSING

SOIL engineering studies served two important functions in the building of the Delaware Refinery. They were a valuable check on the general suitability of the property, and they aided in the location of buildings and processing units, design of foundations and placing of pipelines and earthwork.

When the first options were being obtained on the 5000-acre tract, preliminary soil studies were made to learn the general nature of the subsurface strata. This investigation showed that, aside from the marsh land along the river, the soil was mostly sand and gravel.

The preliminary check on soil conditions were made on all open pits in the neighborhood to determine whether water stood at the bottom or drained off. Engineering records of the foundations of bridges and buildings in the neighborhood were investigated. Logs of water wells were studied where available. Old reports of the U. S. Geological Survey were checked. A Maryland Geological Survey of 1937 showed good soil conditions for bearing structures in the Delaware City area.

After options on the property were procured, first hand comprehensive foundation investigations were conducted by Dames and Moore, California soil mechanics engineers for Braun. These started in the spring of 1954. All told, over 300 borings, from 10 to 120 feet deep, were made on the sites for the administration buildings, processing units, storage tanks and for the docks and piers.

The borings were drilled with three types of equipment—bucket-augur, rotary wash, and wash—the choice depending on the information sought at the individual boring. Soil checks at the borings were supplemented by laboratory shear tests, to determine the shearing strength of the soils and by friction tests to determine the friction between the soils and wood, concrete and sub-surface construction materials. The soil tests were a great aid in determining the specific design values for earthwork and for the foundations of structures.

The soil problems varied in each area—high ground, marshland and waterfront. They all received careful study before the start of plant design. Bedrock was never available, because it lies 600 ft beneath the alluvial soil. The rich, brown topsoil that covered the farmland was stripped off and stockpiled for later use. Underneath it was a firm, brown sand supported in turn by heavier clay soils. Where lenses of soft clay were found in the brown sand, sometimes one to four ft thick and up to 30 ft long, special measures were taken to support heavy loads without settlement.

Process equipment loads and large structural foundations were spread on footings or drilled-and-belled caissons, supported on the brown sand. But for locations where clay lenses existed, the footings were either extended below the depth or the clay bed was removed and backfilled with compacted sandy material. In the design of foundations for large tanks the soil borings proved of great value too. If clay lenses existed within ten feet on either side of the tank shell, they were removed and backfilled before the foundation gravel was placed.

The best locations for the river water pumphouse, the water channels and the separators were determined by test borings. Lab analyses of the marsh soil near the river and the substrata gave data for computing probable settlements and stability of fills. Altogether, 14 million cu yd of dredged material were obtained from the river channels and turning basin. This material was used to fill in and reclaim about 700 acres of land, raising the marsh land an average of 12 ft in elevation.

Test borings along the pipeway from the tank farm through the marshy ground and at the water terminal showed that concrete sleepers should be supported on piles. Other borings along the waterfront located the piers. Other test borings and soundings in the river for the approach channel and the turning basin showed the kind of material that could be expected as dredging spoils.

It is interesting that, despite its nearness to the water, none of the refinery structures required piling for the foundations. Only the piers, pipeway sleepers, marine office, water terminal offices, and ballast water tanks required piling.

Acknowledgement is made to the following for providing information in the preparation of this article: R. S. Stanfield, refinery representative, and R. M. Hunt, supt. of utilities, Delaware refinery, Tidewater Oil Co.; and J. M. Phelps, senior engineer, C. F. Braun & Co.

This team runs th

ORGANIZATION

Manufacturing is directed by this group of widely experienced men. The Delaware Refinery falls within Tidewater's 13-state eastern division, which is the responsibility of George F. Getty II. John McCoy is coordinator in the New York office for the eastern division. Daily operation of the Delaware Refinery is the responsibility of George C. Caine and his staff. The chart on these two pages show the functional relationship of the new refinery's staff.

G. F. Getty II
vice president and manager
East Coast operations

Mr. Getty started his oil career as an independent operator in California in 1947. Before joining Tidewater, he served as manager of several of Western Oil Co.'s divisions, and as executive director and vice-president of that company (now Getty Oil Co.).

J. T. McCoy
New York office
coordinator

Mr. McCoy joined Tidewater as assistant technologist in Research and Development at Bayonne. He was later named divisional supervisor of R&D, and in 1955 was transferred to the New York office of Tidewater. Mr. McCoy has taught at M.I.T.

G. C. Caine
Manufacturing Dept.
divisional manager

George C. Caine joined the company in 1926 as an engineer in the Development Department at Bayonne and the following year was promoted to assistant to the supervisor of the Paraffin and Lubricating Department. Caine was named assistant processing superintendent in 1931; assistant general superintendent in 1938; and general superintendent in 1943.

B. G. Jones
assistant manager

Benjamin G. Jones, a native of Berkeley, Calif., joined Tidewater in 1929 as a chemist in the control lab at the Avon refinery. He became superintendent of alkylation and isomerization process operations in 1944; superintendent of the catalytic cracking plant in 1948; superintendent of the thermal crackers in 1953 and superintendent of cracking in 1954.

J. McDonald
assistant manager

James McDonald, a 1937 graduate of Yale, joined Tidewater at the Bayonne Refinery in 1940 as a junior process engineer, becoming technical assistant to the process superintendent in 1944. Elevated to the post of assistant process superintendent in 1947, he has since the close of the Bayonne refinery been working on engineering phases of the new refinery.

the new Delaware Refinery

Robert Beattie, supt., Engineering, Maintenance and Construction, joined Tidewater in January of 1930 as development engineering supervisor at Bayonne. He was named senior process engineer of the Engineering Department in 1944. In 1951 he became assistant mechanical superintendent of the Bayonne refinery. He was design coordinator on the Delaware project since its earliest construction stages.

Robert Hunt, supt., Utilities, Oil Dispatching and Sulfur Recovery, joined Tidewater in June of 1946 as a process engineer at the Bayonne refinery. The following year he was named technical assistant to the process superintendent and in 1950 he became supervisor of the Paraffin and Lubricating Department. In April of 1955 he was transferred to Alhambra to work on the design of the new refinery.

Raymond Camp, supt., Alkylation, Polymerization, Reforming and Desulfurization, came to the company in 1938 as a chemist in the control lab at the Avon refinery in California. In 1941 he was named an engineer and three years later was appointed foreman of Alkylation and Isomerization. In 1948 he was named superintendent of Steam Production and Water Treating and, in 1953, superintendent of Alkylation and Isomerization.

Dr. Arthur W. Lewis, supt., Refinery Technology, came to the company in 1934 at Bayonne as a development engineer. In 1936 he was transferred to the Research Department and became leader of the Lubricating Grease Section in 1944. Later he was appointed supervisor of the Research Laboratory. His most recent duties have been in connection with the new refinery project.

Lloyd Forbes, supt., Crude, Coking and Cracking, joined Tidewater in 1941 as a chemist at the Watson, Calif., refinery and, following World War II, became a process engineer. He later served as a senior research engineer at Avon, then as technical operating foreman of the catalytic cracking plant. He acted as an engineering liaison on the refinery modernization program at Avon.

E. L. Raun, supt., Alkylation, Polymerization, Reforming and Desulfurizing, joined Tidewater in 1934 as an engineer in the Process Department at Bayonne. In 1941 he became assistant to the process superintendent and in January of 1947 he was named process superintendent. His most recent post was that of process superintendent and acting mechanical superintendent. He has been connected with the new project for some time.

Ray Harrison, Jr., supt., Economic Planning and Accounting, is new to the company, bringing with him an extensive background in engineering, economics and accounting. He joined Tidewater this past May, after several years in market research with a chemical concern. He has a BS and Ch E from Yale and an MBA from Harvard Business School.

Leroy Scott, supervisor, Employee Relations, was formerly assistant to the Divisional Employee Relations supervisor. He joined Tidewater in 1929 as a messenger at Bayonne. In 1937 he transferred to Employee Relations as secretary to the supervisor. In 1955 he was named assistant supervisor of Employee Relations at Bayonne.

M. David Haynes, supt., Crude, Coking and Cracking, became associated with Tidewater in April 1929 as a development engineer at Bayonne. In January of 1947 he was named chief process design engineer and was transferred to Alhambra in March of 1954 as a member of the group supervising the design of the new refinery.

R. S. Stanfield, refinery representative, came to Tidewater in August of 1920 as a construction engineer at Tulsa, Okla. He was later superintendent of Tidewater's Drumright, Okla., refinery. In 1935 he moved to Bayonne as supervising engineer, and that year was named chief engineer. He has been on the new project since its earliest stages in 1954, and was responsible for locating a suitable site.

TIDEWATER PLANT & PEOPLE

"... standards high

TRAINING MANUALS were developed for all courses given

CLASSROOMS WERE OFTEN AT JOB SITE, as in this control room

HIRING, TRAINING

By STUART D. BOYNTON
Assistant Editor
PETROLEUM PROCESSING

TIDEWATER set standards high for employment at the new Delaware refinery. They wanted people who could cope with the advanced technology of the plant and men with real potential for advancement.

They had no trouble attracting applicants.

In April of 1956 an employment office was opened just off U. S. Route 13 in a big white farmhouse with a tree-lined driveway. A sign along the highway was its only advertisement, but applications piled up rapidly.

Today, though the farmhouse is no longer used the applications on file approach 10,000 and could supply many times the needed personnel.

In addition to men obtained in this way, a number of qualified people came from Tidewater's Bayonne and Drumright refineries, now both closed. Newspaper advertising was unnecessary for all but a few clerical and high-level operating jobs. Wages for refinery work are the highest of any industry in the Philadelphia area. In Delaware there actually is no other refinery. These considerations and others made employment at the plant highly attractive.

When an operating employe was hired he was given tests for mechanical aptitude and mental ability. Clerical employes took the mental ability test, plus the usual skills tests. Because units were coming on stream over a period of months, hiring had to be staggered so operators would be ready when units were. The training period lasted about three months for operating people. Thus, every two weeks or so, a group of about 25 men would be taken on for units scheduled to start up three months later.

Before training began, all employes, whether transferred from another Tidewater refinery or new, were put through two days' indoctrination. On the first day, George C. Caine, Eastern Division manufacturing manager, welcomed each man individually. Following this, they learned about the background and organization of the plant and the company. Next, they were told about company benefits, rules and policies. On the second day of indoctrination, the men were taken on a tour of the refinery, then told in detail what their training would be like. On the following day they went into their respective training programs.

Men hired for the non-supervisory operating jobs were all put through two courses: a Basic Operator Training Course of two weeks, and Unit Training for 10 more weeks. General Service Operators (the only maintenance-type workers Tidewater employs) were given the basic course and then a different sort of advanced training. Supervisory people, whether technically trained or not, received a 50-hour training, half of it in refinery processes (an overall view), half in techniques of supervision.

Operator training

The Basic and Unit courses for operators were given to experienced as well as inexperienced men. It was felt that even those with several years of refining behind them might not be sufficiently familiar with the plant's newer types of units. The men were told that their training period would be an important factor in the rating they received when finally assigned to units. Of course, some of the men formerly employed at other Tidewater refineries, or with considerable operating experience, were hired with the

because technology was so advanced"

understanding that upon satisfactory completion of their training they would take the higher operating jobs. A man's appraised performance, company seniority, and refining experience, then, were all taken into account in placement. As a result, a few men were moved from trainee status to the highest operating rating. A larger number were moved up a notch or two.

The possibilities for advancement acted as a powerful motivating force upon the men in training. The competition was keen, and they worked hard. The average for the Basic Operator Course was a remarkable 75; for the Unit training it was even higher, between 85 and 87.

Basic training

In the two-week, Basic Operator course, the mornings were spent in the classroom, the afternoons mostly in the refinery. Class began at 8:00 a.m. with a review of the previous day's work. Then a new topic would be introduced in a lecture, followed by a quiz to see what the men had grasped.

After lunch there was a tour of the unit discussed that morning. Here the trainee would be asked to apply his knowledge of theory to the unit. The instructor might say: "This morning we discussed condensers. Where is a condenser on this unit?" A man would point it out.

Then the instructor might ask another man: "Why do they have a condenser on this unit? What is the theory of operation?" The instructors would in this way evaluate each man's understanding of theory and his ability to relate it to the unit's operation.

Supervisory people were the instructors, as part of their own training had been in how to give instruction. At 3:00 p.m. the trainees would return indoors and study the next day's work until 4:30. Work at home was a necessary part of the course for most of the men.

Unit training

The 10-week Unit Training Course was designed to give the trainee a complete understanding—theory and operation—of the unit to which he was assigned. Classes were conducted by area shift leaders (the first line of supervision), technical foremen, staff engineers, and others. These men were chosen to give the instruction because it was felt that they, too, needed a chance to brush up on their units.

In both courses visual aids were used extensively. There was a model of an instrument panel, cutaway models of certain pumps (provided by the supplying firms), many diagrams, photographic slides, and even films. Allis-Chalmers contributed cutaway models of their electrical switch-gear. Moreover, much of the instruction on equipment was delivered by field engineers of these supplying companies.

Manuals for the two courses were prepared by Tidewater engineers. They received assistance from people at the company's Avon, Calif., refinery and at C. F. Braun. The whole job of writing 17 manuals—one for the Basic course, 16 for the Unit training—took 5½ months.

Training the GSO's

The General Service Operators were given the same Basic course as the unit operators. In place of Unit training they received instruction in repair of equipment, theory and operation of pumps, basic hydraulics, review of applied mathematics, blueprint reading, use and care of hand-tools, fire-fighting, etc. In addition to emergency maintenance work an important GSO function is to act as the main fire-fighting force for all minor-alarm fires.

The supervisors' program

Supervisory training was given to operating and non-operating people alike. One-half of the program—25 hours—was spent in an overall review of refinery technology, including the theory and operation and a description of processes. The other 25 hours were devoted to instruction in human relations (motivation) and supervisory techniques (e.g., interviewing, giving job instructions, handling subordinates). This course was prepared by the Training Coordinator, who used two texts: "Foreman's Basic Reading Kit," published by the American Management Association, and a case book prepared by the American Petroleum Institute's Committee on Training.

The 50 hours were all conference discussion. The mornings of two weeks were used for this and for additional instruction in public and labor relations. In the afternoons, the operating supervisors followed the construction of their units out in the field, acting somewhat as roving inspectors while at the same time learning more about the units. From their experience they were sometimes able to suggest modifications in the plans as construction progressed.

Training for safety

All new employes were given a two-hour introduction to safety. Supervisors were put through a five-hour course, which qualified them to teach safety. In designing the course, safety consultants and specialists were utilized. The course stresses the individual's responsibility in causing accidents.

This approach has been adopted by the entire company and was given credit for cutting the company accident rate by a considerable margin in 1956. Besides this formal course in safety, safe operation of units was stressed throughout the operator training program.

Besides the two-hour training given to new employes, another two hours of instruction were given to General Service Operators and unit operators in the use of safety equipment, including respirators, testing devices, gas masks, and protective clothing. The Safety Department plans to schedule each man for a refresher course a few months after he takes it the first time.

The refinery is the first place in the Delaware Valley to use a first-aid course specially prepared by the Red Cross for industry. First, Red Cross instructors worked with a group of refinery people until they were qualified as instructors. These men then administered the industrial first-aid course to other employes. The 10-hr course is a streamlined version of the Red Cross' usual 22-hr course and was designed with the help of refinery personnel. Instructors are in various parts of the plant, and training classes are held in the field in small groups. The company expects all employes eventually to complete it.

Acknowledgement is given to the following people for their assistance in the preparation of this article: LeRoy Scott, superintendent, employe relations; Walter Harrison, assistant superintendent, employe relations; George C. Chartrand, employe relations assistant-training; J. Victor McCool, supervisor of safety; and Charles E. Waddell, employe relations assistant-medical—all of the Tidewater Delaware refinery.

". . . second 500-gpm

FIRE CHIEF Les Johns inspects the hose on top of one of the two foam trucks

PROTECTION

By L. C. JOHNS, Fire Chief
Tidewater Delaware Refinery

TWO new foam-liquid proportioning trucks stand at the heart of the Tidewater refinery's modern fire-fighting organization. Of "Aer-O-Foam" design, these trucks are equipped with 1250-gpm, class "A," 2-stage fire pumps and Aer-O-Flow indication equipment.

Each truck, carrying 900 gal of foam liquid, can produce 14,000 gpm of foam while simultaneously throwing streams for cooling and other purposes. Auxiliary supplies of foam liquid are right at hand in the form of two 700-gal tank trailers, which can be swiftly hooked to trucks and transported to the fire.

This modern method of foam application is not only faster but requires less manpower. These trucks also carry 1500 ft of hose, first-aid and rescue equipment, deluge sets, nozzles, fittings and hydraulic foam towers that can be raised 60 ft.

A third truck with a 500-gpm, 2-stage fire pump and a 320-gal water tank, is used for grass and the smaller refinery fires. All fire trucks are radio equipped.

There are two different types of tank construction in the refinery, requiring different methods of applying foam. Foam is applied to fixed cone-roof tanks by means of a piping system that terminates outside a dike wall. For floating roof tanks the hydraulic foam towers are used.

An Aer-O-Foam proportioning trailer is located at the water terminal for ship, dock and ballast tank fires. The fire water system in this area is separate from the refinery's main system and has a pumping capacity of 3100 gpm at 150 psi. Suction is taken from the river by vertical pumps, two electric and one operated by gasoline motor. The gasoline-driven pump stands by to pressurize the fire water system should electrical power fail.

The fire water system in the main refinery has a pumping capacity of 10,500 gpm at 150 psi. A 50,000-bbl water tank supplies three fire pumps, two electric and one diesel motor operated. Once again the diesel pump is used to maintain water pressure, in case of an electrical power failure. In the event of a large fire, if the water tank level drops, an auxiliary water supply is available from the river water cooling system.

Sprinkler systems exist in most of the buildings, and the Control Laboratory is equipped with an automatic CO_2 system. Where immediate cooling is a necessity—on pressurized LPG storage tanks, vessels and loading racks—spray and sprinkler systems with both automatic and manual controls have been installed.

At strategic places in the process areas are hose reels containing 100 ft. of 1¼-in. hose with fog nozzles. These are located so that at least two hoses can be put on any fire immediately. Also in the process area are stationary monitor nozzles capable of applying 500 gpm of water in either straight or fog patterns. They can be turned on, locked in position and left unmanned, allowing unit operators to take care of any disruptions in their unit.

Throughout the refinery, 30-lb dry chemical extinguishers are used extensively, except for electrical switch houses, which are equipped with 15-lb CO_2 extinguishers. Buildings subjected to class "A" fires contain water-type extinguishers.

Fires are reported by dialing "8" on any refinery phone. Fire calls are received by the main gate guard, who actuates the alarm system by sounding the fire siren and announcing the fire location to all radio equipped vehicles. Alerted fire brigades consisting of General Service Operators and laboratory personnel respond with the trucks and fight the fire under the direction of the fire department supervisor on duty.

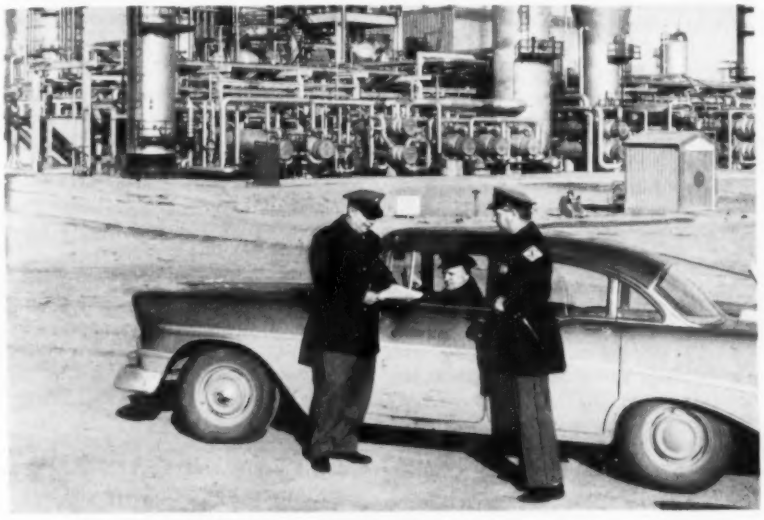
Should a major alarm fire or disaster occur, a force consisting of 125 specially trained employes would be called. Another source of manpower on which we rely are the local volunteer fire departments. The towns of Delaware City, New Castle and others

pump starts if pressure drops"

are close enough to mobilize an effective force in the refinery in a hurry. These volunteers are cooperative and interested in learning how to fight oil fires.

Training the fire-fighter: As part of their indoctrination all new employes receive two hours' training in fire rules and methods of fire prevention and control. All employes are also given a two-hour course on the fire drill grounds to learn to use the types of fire equipment for the common sort of refinery fire.

The fire brigades, the refinery's main fire-fighting force, have the most intensive training of anyone at the plant. Their training program consists of 1½ hours approximately every three weeks and covers all phases of fire protection.



PROTECTING THE REFINERY is the job of these guards

Guard Protection by Contract—a First

By *ALAN CORNERETTO*
Assistant Editor
PETROLEUM PROCESSING

TIDEWATER decided to contract out its plant protection for greater all-around efficiency. Although the plant has been operating only a short time the decision is already paying dividends.

Contracted out protection gives Tidewater these advantages:

- Access to experienced men
- Simplified personnel paperwork
- Less inflexibility in personnel assignments
- Helpful police cooperation
- Increased dependability of security
- Greater overall economy

The key to any plant protection system is the security personnel. Tidewater is fortunate to have a system headed by vigorous, friendly Major Carl Schnetter, former number-two man in the Delaware State Police system, and now director of security at the Delaware Refinery.

When Schnetter and his associate Captain John W. Conrad, a former state police commander, set up their organization (the Delaware Protective and Investigative Agency) they sought men experienced in police work who would be public relations assets to Tidewater.

Included on the staff are men from town, city, county, and state police organizations, including a former police chief. Almost all of the men are between 30 and 34 years old. A carefully controlled amount of integration between the security force and the plant personnel is resulting in both smooth relations and efficient protection. This despite the problems of providing protection during many months of construction and many more of transition to operating status. The 15-man force, now augmented by temporary personnel, is distributed among the different posts on the refinery in the three shifts this way:

Shift		8-4	4-12	12-8
Main gate*		1	1	1
Const. gate		1	1	1
Riv. Rd. gate		1	0	0
Marine gate*		1	1	1
Warehouse	Sat	1	1	1
Warehouse	Sun	1	1	1
Patrol		1	1	1

*Plus 1 1/5 men per day for relief

Men on patrol use the Detect system of checking-in on their rounds. One radio-equipped patrol car is presently available, with another likely. Only the refinery area proper is fenced in—with unlighted 6 and 10 ft fence.

All guards receive one week of indoctrination training from Tidewater in refinery security problems. Director Schnetter constantly stresses the importance of courtesy.

In common with other coastal refineries, the Delaware refinery has problems brought to it by the sea. The security officers have to work with the regulations of the U. S. Immigration, Justice, Customs, and Health Departments, as well as the port authorities in their dealings with tanker seamen who dock at the refinery's three piers.

Also in common with plant protection practice elsewhere, the security force at the Delaware refinery handles many small chores that are only indirectly connected with its main assignment. Yet many of these services contribute to the harmony existing between plant personnel and the plant protection group.

One popular service is a parking lot check that discovers lights left on, tires going flat, and other difficulties that the workers prefer to learn about sooner rather than later.

This service is typical of the bonus that Tidewater's contracted-out plant protection provides. In every way it's an unusual set-up. The personable young, alert guards offer day-in, day-out security that's both efficient and courteous. They're setting an example that may have far-reaching effects.

Acknowledgement is made to Carl Schnetter, supervisor of guards, Tidewater Oil Co., Delaware Refinery, for his helpful assistance in providing information for this article.

COMMUNITY RELATIONS

By VIRGIL B. GUTHRIE
Associate Editor
PETROLEUM PROCESSING

THE ACHIEVEMENT of the Tidewater Oil Co. community relations program in "selling" the plan for a refinery to what is primarily a non-industrial area was pinpointed in the address of Delaware's Governor J. Caleb Boggs at the dedication of the new Delaware refinery on May 23.

He praised the Tidewater company for "having preserved the natural beauty and the natural resources of the land surrounding the new refinery. The enterprise will give higher material standards to the citizens of the state."

The program for bringing Tidewater into Delaware as a friend, ready to assume its responsibilities to the community where its plant was located, rather than as a large outside industrial concern interested only in end results, was not a child of circumstance. Long before any formal announcement of plans was made, the Tidewater management, the public relations department, a Wilmington public relations firm retained by Tidewater, and company officials had all been studying the Delaware City location.

Study the state and its people

It was realized that Delaware was small in land area, that what went on in one section was of importance to the entire state. The fact that the state, outside of a few areas, was non-industrial was appraised. Also strongly considered were the facts that the people loved the beauty of their countryside, were proud of its historic lore, and were loath to see these conditions changed. The Tidewater people knew that—for a petroleum refinery particularly—there would be natural suspicions to overcome with respect to smoke, odors, and contamination of the surface streams which are so widely used for recreational purposes.

These background facts were being assembled while land appraisers were still busy, options were being quietly taken up, soil studies being made and other work carried on preliminary to the final selection of a site.

Even before the property was purchased, the company community-relations program had already helped iron out two obstacles to a refinery in the area. These were: 1—securing the enactment of a zoning regulation in New Castle County, which had been pending, to permit heavy industry to locate in this area; 2—securing the amendment of a state law which had formerly prohibited almost any kind of heavy industry to locate within three miles of the Governor Bacon Health City, near Delaware City.

Answer community questions

One important part of the community-relations program that had to be overcome was the natural suspicion of neighbors that a refinery might be a nuisance because of noise or pollution of the atmosphere and ground waters, or that the safety of the area might be endangered. This problem was attacked from the start by taking the public into complete confidence as to what type of plant would be built and how it would operate. Maps were spread out on tables at meetings. The nature and purpose of the various units of the plant as designed were explained at meetings with public officials and with civic groups. The advance methods to be installed for avoiding smoke, fumes and waste in ground waters, and the methods for fire and safety protection were explained. Questions from any source were noted and given straightforward answers.

In addition, town and county officials were taken to inspect a nearby modern refinery to see for themselves the operating conditions at today's refineries. By this and other means, the Tidewater company took the community fully "into the know" on its plans and thereby set at rest many of the rumors that ordinarily spread through lack of knowledge.

What you're doing and why

Likewise, the Tidewater community program took definite steps to establish the new refinery as a friend in the neighborhood. From the start the company participated in civic undertakings. In some cases people who had sold their land to the refinery were not asked to move out. Their acres were leased back to them and they went on living as they had been before the oil company came in. The public announcements of the new personnel coming to operate the refinery always carried their home addresses, so they could be identified as residents of the nearby towns.

A more intangible, but nevertheless real, community-relations program for the Tidewater company stemmed from the fact that Delaware people still regard their state as agricultural land. In fact, agriculture still utilizes nearly 65% of the total land area. Many sections, including the Delaware City area, cherish the gently rolling farm lands.

The Tidewater company overcame the uneasiness as to what an industrial concern would do to the appearance of their countryside by leasing 3,000 acres, more than half the refinery site, to the Seabrook Farms Co., a New Jersey enterprise which raises corn, beans, peas and other vegetables for deep freezing and packaging. Even while process-unit structures and tanks were going up in the summer of 1956, the fields in the refinery plot along the highway were green with growing vegetables—visible proof that a refinery need not be an eyesore in the community or a threat to vegetation.

Another part of the Tidewater community-relations program which followed the general theme of letting the public "in on the know," was launched as soon as the first public announcement of the new refinery was made. Through the newspapers and photographs, complete reports were made on all stages of the work when each new process unit was started, when dredging started for the ship channel, when pipelines were laid, and so on.

If there is anything about Tidewater's new Delaware refinery that its neighbors do not know, it is because they either have not kept up with the newspapers or have not asked questions of company people

Photo Credits

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All others are PETROLEUM PROCESSING photographs.

THANK YOU!

The Tidewater Delaware Refinery was built through the hard work and cooperation of many people. To all of them we extend our thanks and appreciation. To the management and engineers of the Tidewater Oil Company. To the engineers, construction-staff, and workers of our own Company. To the licensors, the sub-contractors, the many suppliers. And to the officials and members of the A F of L Building and Construction Trades Unions. All may take pride in this accomplishment.

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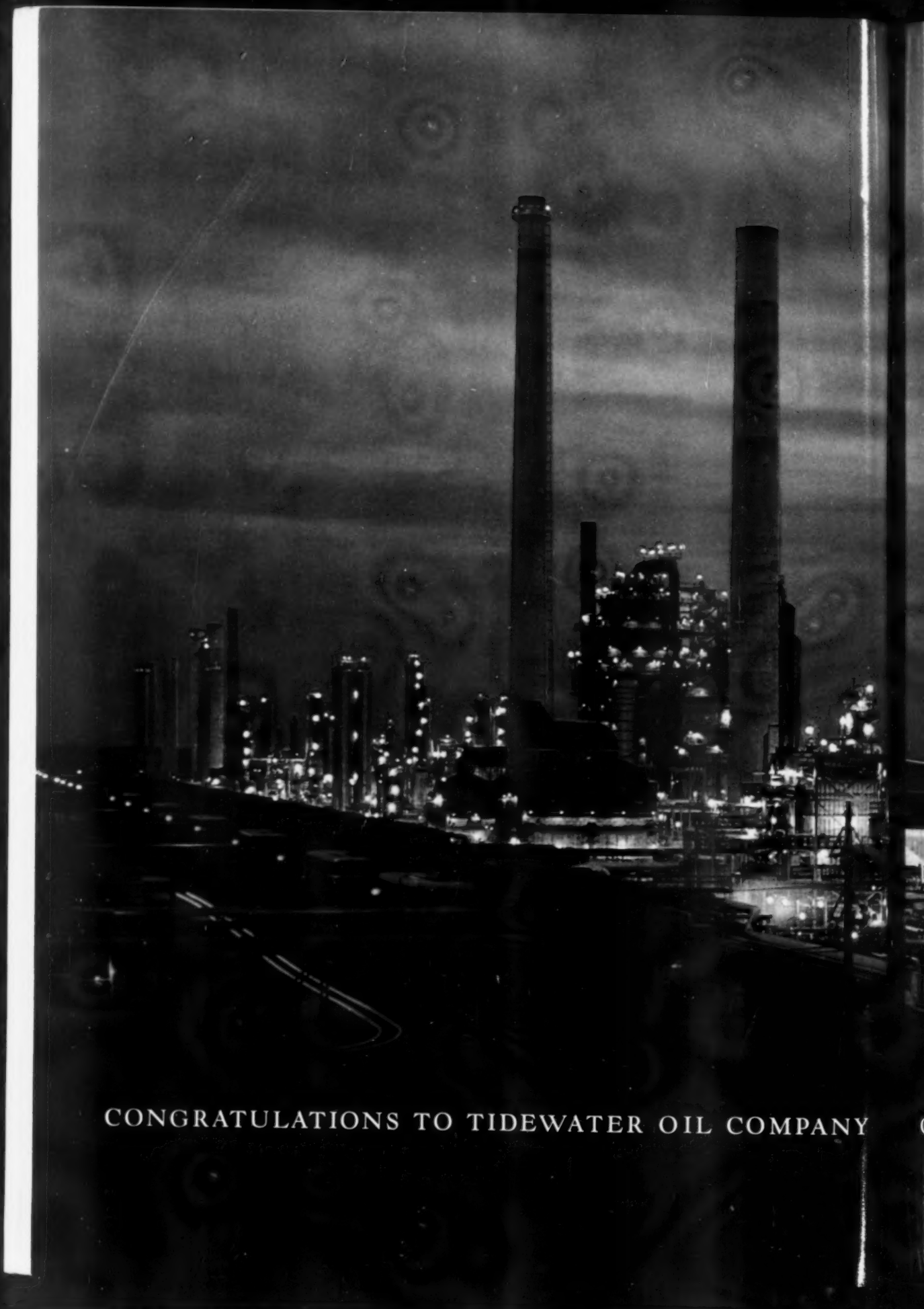
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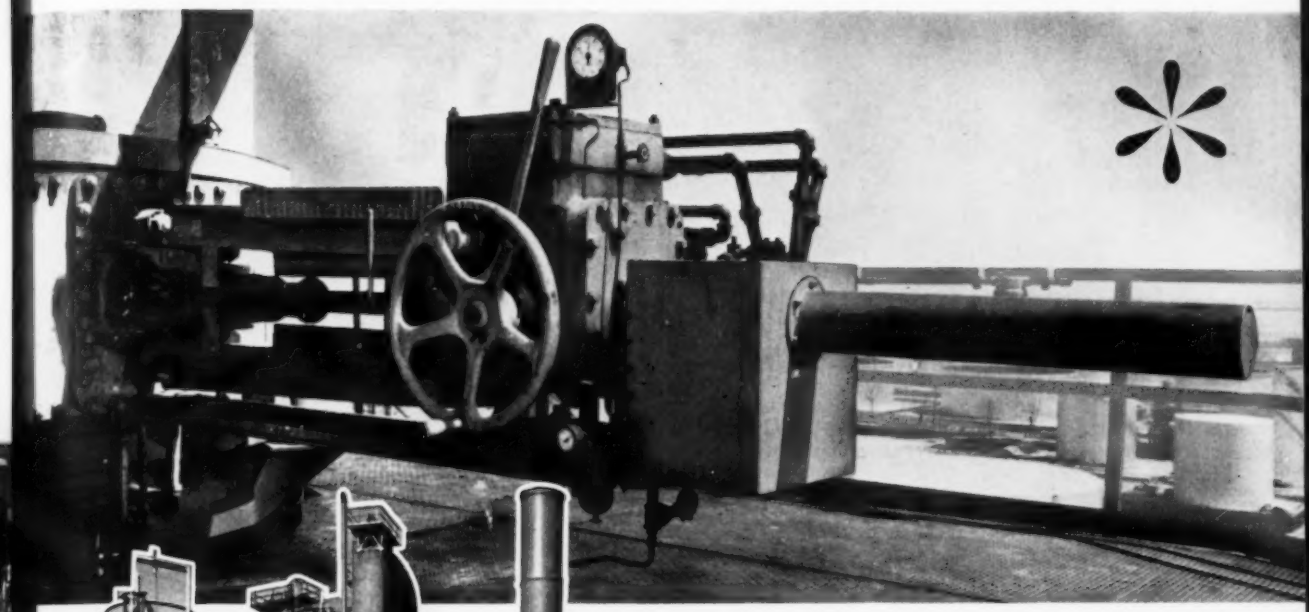

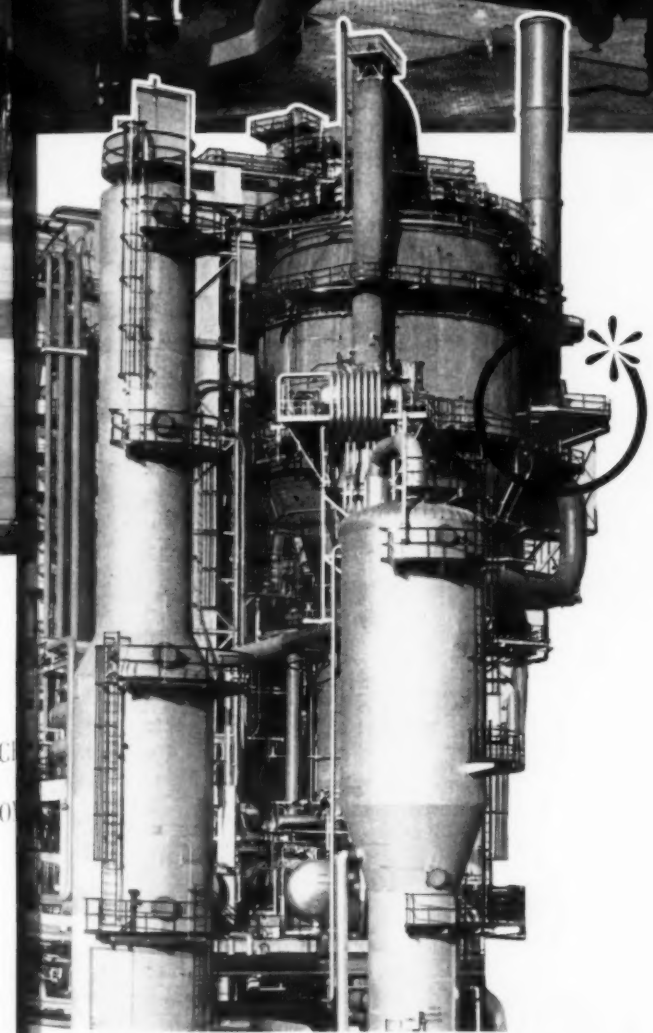

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Seventeen Rotomotors were specified and installed by contractors in Tidewater's new Delaware Refinery—the world's largest integrated refinery.

Photographs show one of a pair of these unique pneumatic actuators operating a 72-inch double disc regenerator vent valve on a large diameter stack, 200 feet above ground on M. W. Kellogg Company's Orthoflow unit. The two Rotomotors actuate opposed sliding valve discs, each covering one-half of the rectangular port opening, 38 inches by 50 inches. Discs travel 25 inches from fully closed to fully opened position. Required positioning accuracy of one part in 400 of stem travel is obtained despite heavy stem load of 18,000 lbs. Assembly is completely air operated, hence explosion-proof.

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is described with schematic diagrams in Conoflow Technical Bulletin 107-2, available on request. Send for your copy today—it will be mailed promptly.

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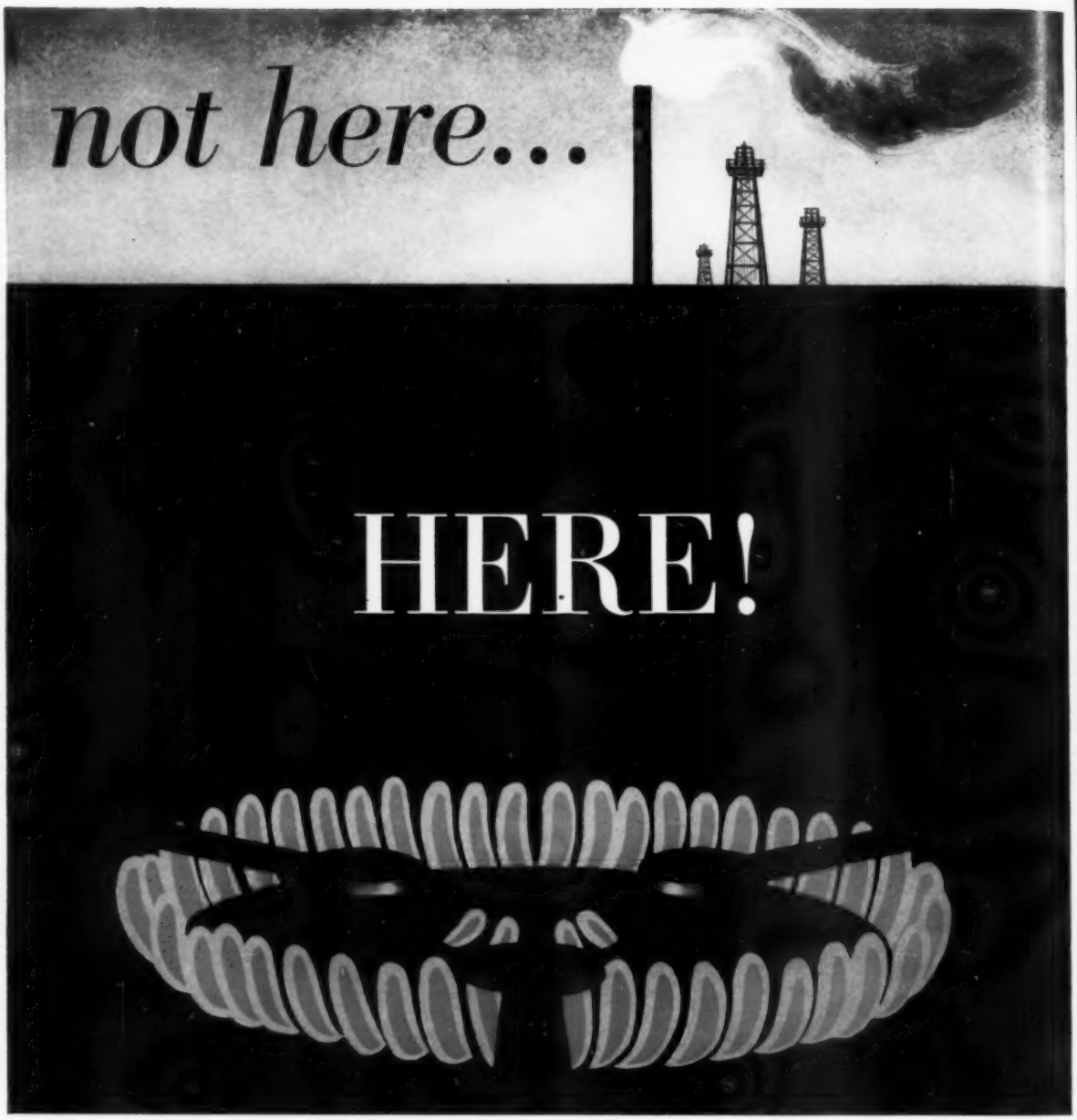

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Wet or sour gases, once flared as a nuisance, now produce millions in revenue — thanks to the glycols and ethanolamines. If you use these versatile chemicals for gas dehydration or purification, you want to be sure of steady supply and instant service. Allied glycols and ethanolamines are available in tank car lots from Nitrogen Division's Orange, Texas plant, and in tank trucks or drums from warehouses in principal producing areas. Allied's technical specialists are always on call to help with any application problems you may have.

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(To obtain more data on advertised products see page 230)

Your Guide to . . . Petroleum Processing Departments

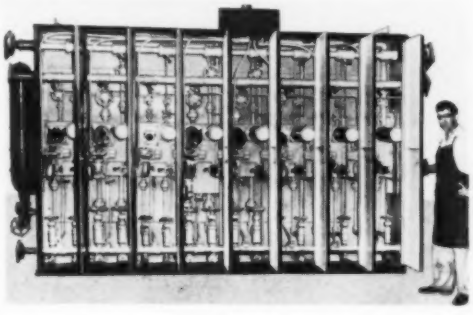
Keep Your Data File Up-to-Date

"Clip-n-File" process data
Cumene production

This three page fold-out flowsheet describes the Mid-Century process for making this important product now in transition. Diagram and text make a handy reference unit. Turn to **p. 181**

"Clip-n-File" engineering data
Unfired pressure vessels code simplification

Something new—a guide to the code that can help you handle its useful detail more easily. This easy-to-apply aid appears on **p. 195**



That's right, hydraulic control

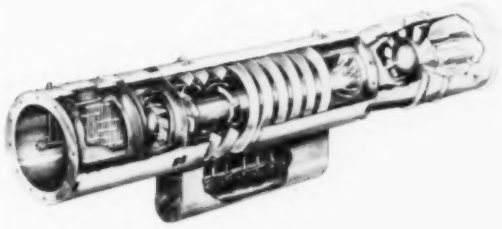
The above unit controls 98 reactor gate valves at Texas Butadiene and Chemical Corp.'s new plant. Hydraulic control was picked because precise, flexible control was needed. Read the details in Plant Practices, starting on **p. 187**

The Old Man on Murphy's Laws

A rare treat, the Bull Pen regulars waxing philosophical. More than theory is involved, however. Forces not understood were shutting down a compressor. So, the boys learned a lesson in practical philosophy. The adventure starts on **p. 191**

The first of a new generation

. . . is the title of this month's editorial. It's subject is the new, and red-hot Tidewater Delaware refinery, whose story has been told on the previous 72 pages. For some perspective turn to the last page in this issue **p. 264**



Centrifugal force bites dust

. . . and gulps it down with water in this compact dust collector of new design. The dust is removed by the combined action of centrifugal force and water. Many more new product developments are described in the What's New section starting on **p. 233**

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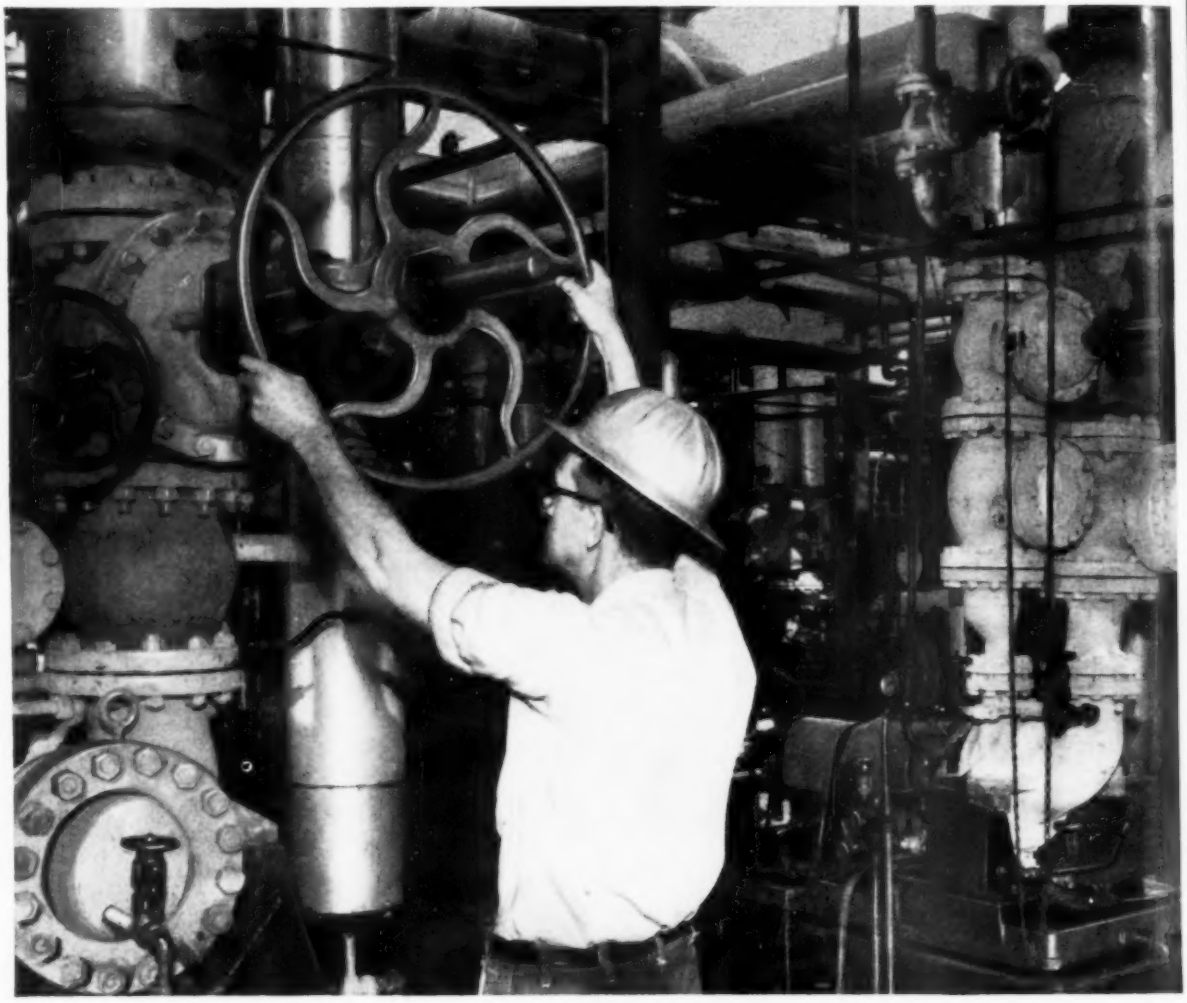
Another Refinery Saves with Crane Steel Valves



14 years on 680° F. bottoms handling ... still no repairs on these valves

These 300-pound Crane steel gates and checks were installed in The Cities Service Refinery Corporation at Lake Charles, Louisiana in 1943.

Installed in the "A" topping unit, on discharge line from bottoms pump, they're still leak-free . . . show no sign of seat damage.

For 14 years these valves have handled this tough 680° F. service with no more attention than routine maintenance at turnarounds. Once-a-week operation at this high temperature hasn't affected their original smooth and accurate seating action.

In Crane Exelloy, these valves have a highly developed seating material for handling hot oil and oil vapor. It has excellent resistance to corrosion, wear and temperature effects. Teamed with Crane steel castings, it assures durable valve service on recommended applications.

Get complete facts on Crane steel valves with Exelloy trim from your Crane Representative, or write to address below.

IDEAS FOR YOU in this book of "Valve Performance Facts." Your Crane Man has a copy for you.

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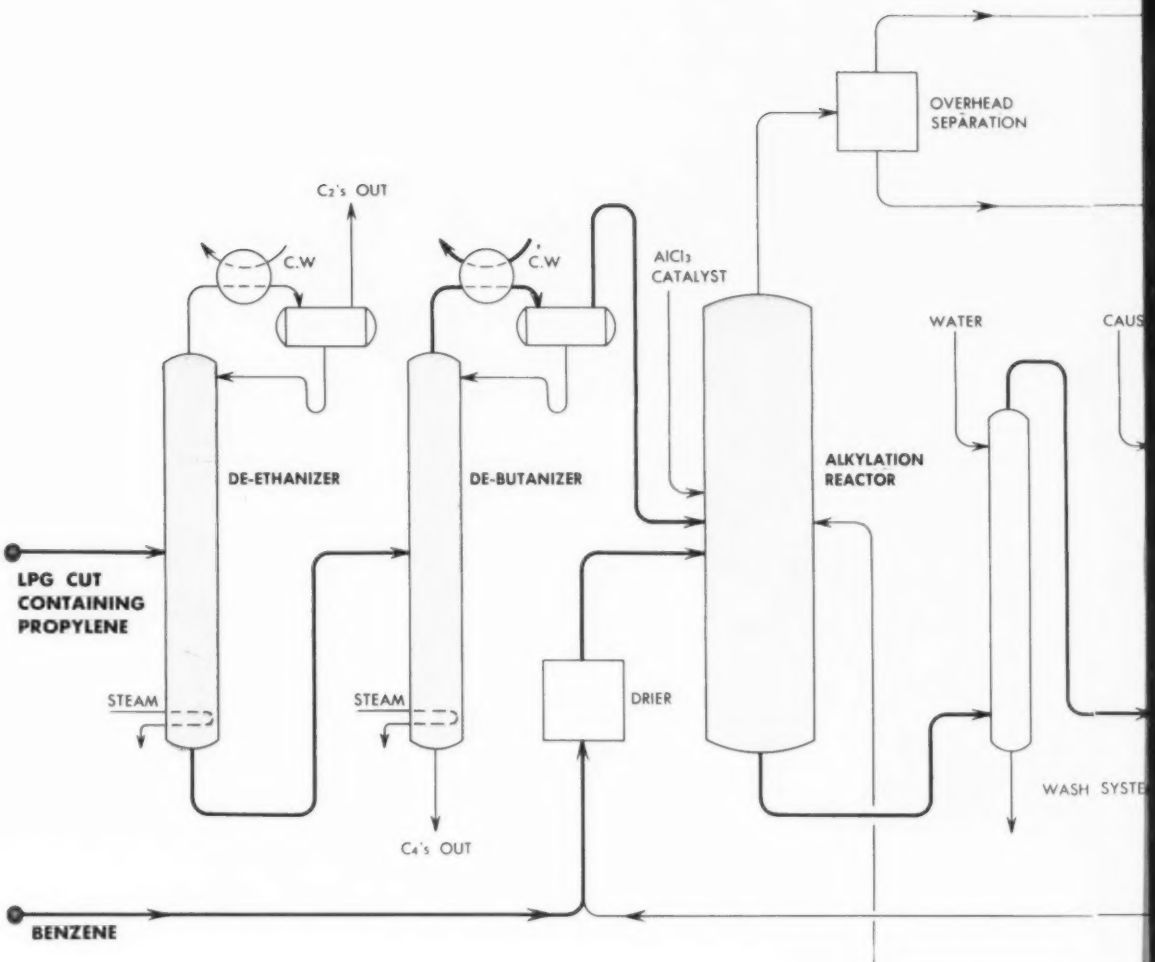


START HERE

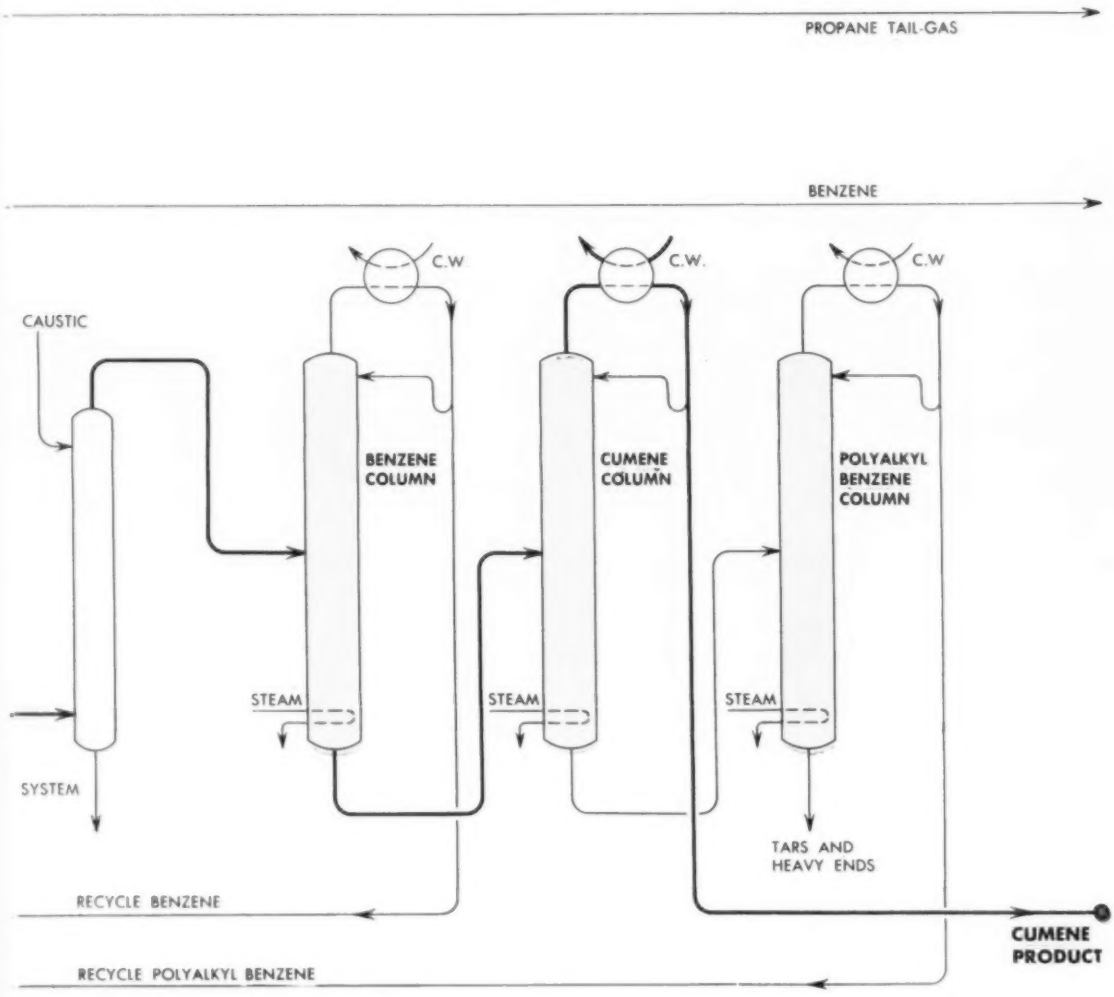
Process—Production of cumene by catalytic alkylation of benzene and propylene. In the Friedel-Crafts exothermic liquid-phase reaction, an olefin is added to an aromatic compound using anhydrous aluminum chloride as a catalyst. The reaction is operated under equilibrium conditions to produce cumene as the sole major product.

Process chemistry—The principal reaction in the production of cumene by the M-C process is:

$$\text{propylene} + \text{benzene} \xrightarrow[\text{aluminum chloride}]{\text{Catalyst}} \text{cumene}$$

Polyalkyl benzene byproducts, formed by reaction of cumene with propylene, are recycled to form more cumene.

Process description—A liquefied petroleum gas (LPG) cut containing as little as 40% propylene is fractionated to remove light and heavy ends. The purified propylene and dry benzene, are then contacted in the liquid phase with aluminum chloride catalyst.



Unreacted propane, and some benzene are taken overhead while product and unreacted benzene are removed as bottoms. The reactor overhead is further processed to recover benzene and remove contaminants from the propane which leaves as tail-gas from the system.

The crude bottoms product, after washing, passes to a stripper where benzene is removed for recycle. The stripped product is fractionated to prepare cumene product and a bottoms fraction consisting primarily of polyalkyl benzene. The latter byproduct is also recycled to maximize cumene yields from the process.

An advantage of the process is that formation of byproduct propylene polymer is minimized in the M-C Cumene Process. This polymer is difficult to separate from desired product.

Product—Cumene was formerly an important ingredient of high octane aviation gasoline. Cumene is now principally a chemical intermediate for making phenol.

The cumene product is of unusually high purity and has an extremely low bromine number. There is little waste in the process. Propane produced is a useful byproduct. Polyalkyl benzene byproducts may be recycled in the process to increase cumene yield.

Cumene made by the process is of sufficient purity to make phenol for the production of caprolactam, a nylon-6 salt.

Yields—Formation of cumene approaches theoretical yield, based on benzene and propylene consumed in the reaction.

CUMENE PLANT designed and engineered by Scientific Design Co., Inc., for Allied Chemical & Dye Corp., Barrett Division, Frankford, Pa., and placed onstream in 1954. Cumene from this section of the plant is the chief intermediate for making phenol, end product of the overall plant.

Cumene Production

. . . by the Mid-Century Process

UNFOLD FOR START OF PROCESS DESCRIPTION

Raw materials—Liquefied petroleum gas cut (LPG) containing propylene, and dry benzene. The process can use LPG gas with as low as 40% propylene in it.

Catalyst—Anhydrous aluminum chloride plus a promoter catalyzes the reaction.

Installations—The Barrett Division of Allied Chemical & Dye Corporation, at Frankford, Pa., has been operating a cumene plant designed by Scientific Design since April 1954. Mitsui Petrochemicals Industries, Ltd. are building a 40,000,000 lb/yr plant at Iwakuni City, Japan. The Mitsui cumene plant is part of a large petrochemical complex that will also produce ethylene oxide and terephthalic acid.

Licensor—The M-C Cumene Process is licensed by the Mid-Century Corporation, 910 South Michigan Ave., Chicago 80, Ill.

Scientific Design Company, Inc., 2 Park Ave., New York, N. Y., is licensing agent for the process abroad, and is an authorized contractor for the engineering and construction in the United States.

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NEWPORT NEWS BUILT two 39'-7" horizontal gas scrubbers, such as this, for J. F. Pritchard & Co. They were made of ASTM-A212 Grade B fire box steel, with structural mesh steel interiors.

Gas scrubber made of 2⅞" steel

Newport News builds almost any type of pressure vessel and other heavy process equipment

Here is one of two horizontal gas scrubbers recently built for an operating pressure of 1800 psi at 300° F.

Newport News made both vessels from fire box steel, 2⅞ inches in thickness. We formed and automatically welded this steel into sections having a diameter of only 4 feet.

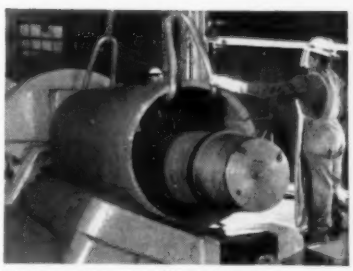
Rolling thick steel to this small diameter...no easy accomplishment, as you probably know . . . demonstrates the sort of jobs Newport News takes in stride.

Almost any type of heavy processing equipment is readily constructed by Newport News in a 225 acre plant comprising huge, fully equipped fabricating and machine shops, foundries, forge and die shops, heat treating and allied equipment as well as complete test facilities.

Newport News shop erection of fabricated units helps to speed assembly at your plant site.

Get a bid from Newport News on your present or future projects. Get the benefit of specialized production techniques. Look over the many ways in which Newport News can help you . . . write for "Facilities and Products", a very interesting booklet. It's yours for the asking.

ENGINEERS Desirable positions available at Newport News for Designers and Engineers in many categories. Address inquiries to Employment Manager.



ROLLING 2⅞" STEEL for gas scrubbers. The steel, in a hot condition, was formed on the heavy bending equipment shown here. It will cold roll mild steel up to 3 inches thick, and will hot roll any grade of steel up to a thickness of 5 inches.

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the comparative values of furnace design as applied to operating requirements.

It's quite simple

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Whenever all these 9 specifications are applied to all the operating requirements, you can be sure PETROCHEM ISOFLOW FURNACES will be found most economically desirable.
No other furnace design can claim the recognition and acceptance achieved by PETROCHEM ISOFLOW FURNACES . . . starting with one installation in 1940, January '57 records more than 1650 ISOFLOW FURNACES in operation and under construction—a record that is incomparable just as all Petrochem Isoflow furnaces are more economically desirable by any comparison.

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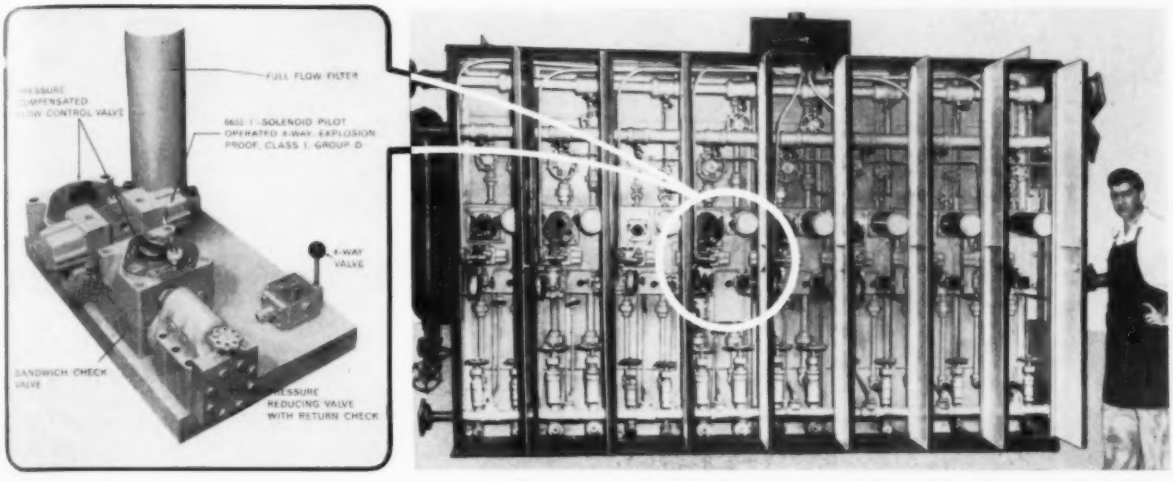
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Hydraulic system

Controls butadiene reactor product valves

TEXAS Butadiene & Chemical Corp.'s decision to use an all-hydraulic control system on the reactors of its new plant in Houston, Texas, aroused sharp interest among other petroleum and petrochemical processors. Some 98 gate valves for seven reactors are controlled by hydraulic control units.

In planning the new plant, flexible control over the flow of ingredients into the reactors was important, as well as fast operation and low initial cost of a control system. Conventional direct-gear connected electric motor control lacked the flexibility needed to compensate for changes in product viscosity. To use motor control for flexibility and increased operating speeds would have required an expensive and unwieldy installation. The use of air diaphragm operators, on the other hand, was limited by the valve size. The size of gate valves needed ranges from 4 to 30 in.

Hydraulic controls offered precise control over product flow, simple operation, a central power supply, and lower cost. Only one source of power is required, which is a 30-hp central power unit for the hydraulic system. If electrical controls had been used the power requirement would have been between 400 and 500 hp.

At the butadiene plant, product gate valves are operated by small, light hydraulic cylinders, which in turn are operated by solenoid valves at the central control panel. Each of seven control units controls the gate valves on one of the reactor vessels. All valves, filters and hydraulic control components are mounted on panel boards—as shown above. In each cabinet is an eighth panel with a circuit to operate an emergency reactor bypass valve.

To reduce instantaneous horsepower demands, the system includes a total of ten 10-gal hydro-pneumatic accumulators. These discharge about 20 gal of oil every three minutes. High pressure oil from the power unit enters the individual panels to 4-way valves, which in turn control the flow of oil to the cylinders actuating the gate valves.

To avoid seat jamming, it was necessary to use lower pressures for closing the gate valves and higher pressures for opening them. This was done by connecting the "close" cylinder port to a pressure reducing valve, permitting a reduced force to be maintained when the valve is closed.

Size of the operating cylinders vary from 2-in. bore and 4 to 8-in. stroke to 6-in. bore and a 32-in. stroke. On one valve that requires a long, slow opening, a second control valve with a return-free flow check between the 4-way and pressure-reducing valves is used. This controls the opening speed by metering the exhaust oil from the cylinder.

To ensure trouble-free operation, high filtration of the hydraulic oil is accomplished. In addition, a magnetic basket in the reservoir pulls out any iron particles. The entire electrical

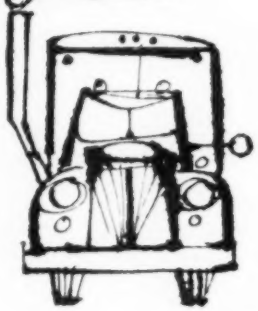
Steel staging rides high

THE mechanical department at Atlantic Refining Co.'s Philadelphia refinery recently faced a real problem. A leak was discovered in the vertical section of the 42-in. flue running from the north waste heat boiler to the Cottrell precipitator. A thorough inspection of the entire flue was necessary, but the horizontal leg was 48 ft above grade and the top of the vertical section rose to 98 ft.

Previously, a hanging wooden scaffold had been used for similar work, and one was again built for initial inspection of the large flue. But when it was realized that the entire length of the flue needed inspection, and possible repair, the wooden staging looked extremely unwieldy and unsafe. Not only would it be necessary to protect the wood from the 450°F skin temperature of the flue, but it would have been necessary to dismantle the wooden platform for every elevation change.

Two foremen—Joseph Karol of No. 3 zone and Henry Mosser of the carpenters—came up with an immedi-

pull more diesels to your pump –deliver full power without noxious exhaust odors –just add Alamask® to your diesel fuels



It takes very little Alamask to subtract the choking odor from diesel exhaust fumes while adding to your sales. Alamask in your fuel will pull truckers, bus operators to your pump. *Selling point to truckers:* operators who tank up with your odor-controlled diesel fuels avoid the increasing demands to "put a stop to engine odors or reroute your lines." *Selling point for buses:* lines that standardize on your odor-controlled fuel increase passenger comfort both in the vehicle and in the terminal – builds good will all along the route. Why not call us about adding Alamask to your diesel fuels? Let us show you how Alamask can give you a new competitive plus.

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ate answer. They designed a steel staging that could be safely and quickly lowered the height of the entire flue. The shop started fabrication immediately and was able to deliver the steel staging before the wooden platform had to be dropped to a lower level.

The new steel platform and rigging clamp design eliminates the need to attach gear to the unit structure, permitting a straight drift for rigging gear. The platform also permits direct contact with the flue, and, with binding chains, provides a stable working area for repairs. Workmen now have a greater sense of security in working from this platform.

The new steel platform also is a time saver. It has cut in half the time required to set up a repair and inspection platform for the waste heat boiler flue. Even if used only for once-a-year shutdown, the platform would more than pay for itself. Experience has shown that flue repairs will be required more often than this.

Company insignia—indian style

INDIANS of the Lummi tribe in northwest Washington state were given a new inspiration in their totem-pole carving when the General Petroleum Corp. located a refinery next to their reservation.

Totem poles, carved from cedar logs or timbers, are Indian records of their leaders and traditions. They are a form of art found only in the Pacific Northwest and British Columbia.

A number of Lummi Indians were in the construction crews that built the refinery. Upon completion, General Petroleum commissioned Joe Hillaire, the tribe's totem pole carver, to carve a totem pole for erection near the administration building. Its only suggestion was that the pole be topped with the company's familiar flying red horse. Hillaire was glad to oblige. Here is how he describes the symbols on the pole:

"On one side, at the base of the pole, is the Lummi tribal crest, consisting of Seen-alth-kea, the mythical serpent, great protector of the people. Seen-alth-kea is entwined around a clump of bulrushes, S-tak-can, symbol of productivity.

"On the other side at the base is the crest of "Hat-Lick," departed leader of the tribe and my father. This consists of a man dressed in the tra-li-

tional costume of the Hillaire family, his tunic decorated with miniature war clubs and deer hooves, his head-dress made of split eagle feathers, a symbol of humility in a great leader. The man stands on a two-headed wolf, with one head black and the other brown, representing male and female.

"The theme for the upper half of the pole is 'Call of the American Indian for equality in industry.' In the middle are four human figures, wearing different head-dresses, or masks. One mask represents a mythical figure, Swie-whee, while the head-dresses represent humility, war, and Cheesan, the mighty wind.

The four are in a dancing mood, calling to Pegasus, the flying red horse, who is standing on the pinnacle, looking down and listening to the call of the Indians for equality in industry."

Spray treatment prolongs life of cooling towers

ROTTING and fungus attack on the redwood of cooling towers at the Carthage gasoline plant of The Chicago Corp., at Carthage, Texas, threatened complete destruction of the towers if allowed to continue. This is a problem with all cooling towers.

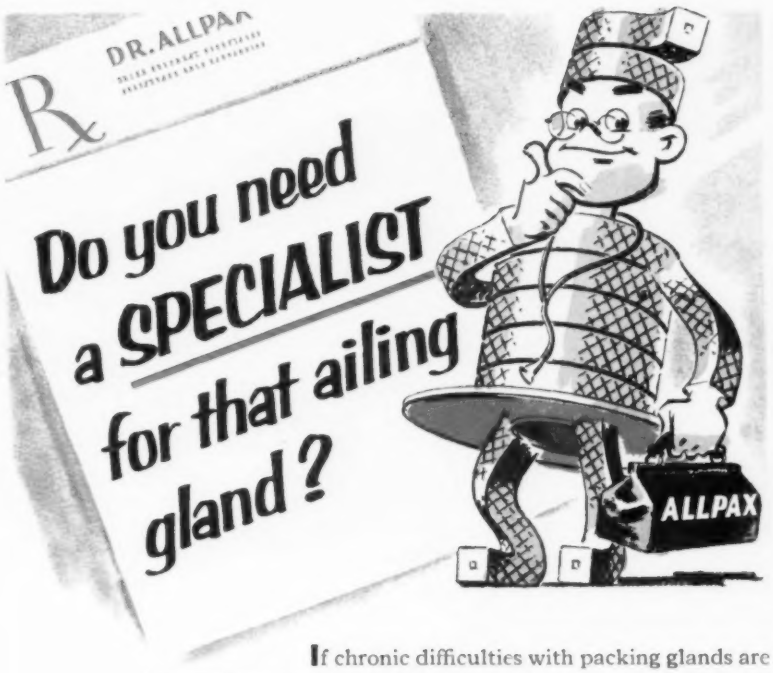
The Chicago Corp. stopped these attacks with a simple and relatively inexpensive chemical treatment that is easy to apply, and involves a minimum of down time.

The treatment consists of a three part spray—one to clean the wood and two more as a preservative. First, the tower is washed down with a solution of water and sodium bisulfate to remove scale and slime and expose the wood to the preservative. Then a solution of copper sulfate, 1 lb gal of water, is applied to the wood. A wetting agent is added to insure complete coverage. Next, a solution of sodium chromate is similarly sprayed on in the same manner.

The two last-applied chemicals react inside the wood fibers to form insoluble copper chromate, which is a wood preservative toxic to fungus.

Applied over six months ago to two towers at the plant, the treatment has effectively stopped the attacks, extended tower life, and cut maintenance costs.

Although commercial rigs are available, Chicago used a plant-built outfit to apply the spray. This consisted of a small pump and a nozzle that put out the short, heavy spray necessary to insure thorough soaking of the wood. Cost of the treatment—less than $1,000 for chemicals for the two towers with a 21,000 gpm circulation.



If chronic difficulties with packing glands are demanding more than their share of maintenance time, let Allpax prescribe for you. In our complete line of mechanical packings, we are sure to have the remedy you need. If your problem is a special one, Allpax will be happy to diagnose your case and design a special packing for your particular requirement.

Allpax packings cut costly downtime to a minimum, and eliminate undue wear and tear on expensive machinery. Contact your nearest distributor or write to the Allpax Applications Consultant at our factory.

A complete selection of:

- ✓ Teflon* Packings
- ✓ High Pressure Packings
- ✓ Metallic Packings
- ✓ Plastic Packings
- ✓ Sheet Packings

*DuPont Trademark

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Distributors in principal cities

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160 Jefferson Ave., Mamaroneck, N. Y.
CANADIAN DISTRIBUTORS: Albion Asbestos Packings Ltd., Montreal 18, Quebec

(To obtain more data on advertised products see page 230)

All materials pass through EVER-TITE Couplings in this

Esso

blending operation

Installation of Ever-Tite Heavy Duty Couplings with Dust Plugs

In refineries, too—

EVER-TITE

QUALITY QUICK COUPLINGS

speed operations

EVER-TITE Adapter and Coupler

EVER-TITE Shank Hose Coupling

Install dependable EVER-TITE Couplings in

loading racks

•

manifolds in storage areas

•

manifolds in blending operations

•

container filling devices

•

fire hydrants and water lines

•

acid handling at storage and transfer locations

The installation pictured above, showing Ever-Tite Couplings in an Esso blending plant, typifies a trend in refineries everywhere. More and more refineries and petrochem plants are using Ever-Tite Couplings to speed operations, prevent leakage, and reduce losses of product.

There are many applications for Ever-Tite in a modern refinery—as indicated in the list at the left—where the dependable performance of Ever-Tite Couplings can effect definite economies.

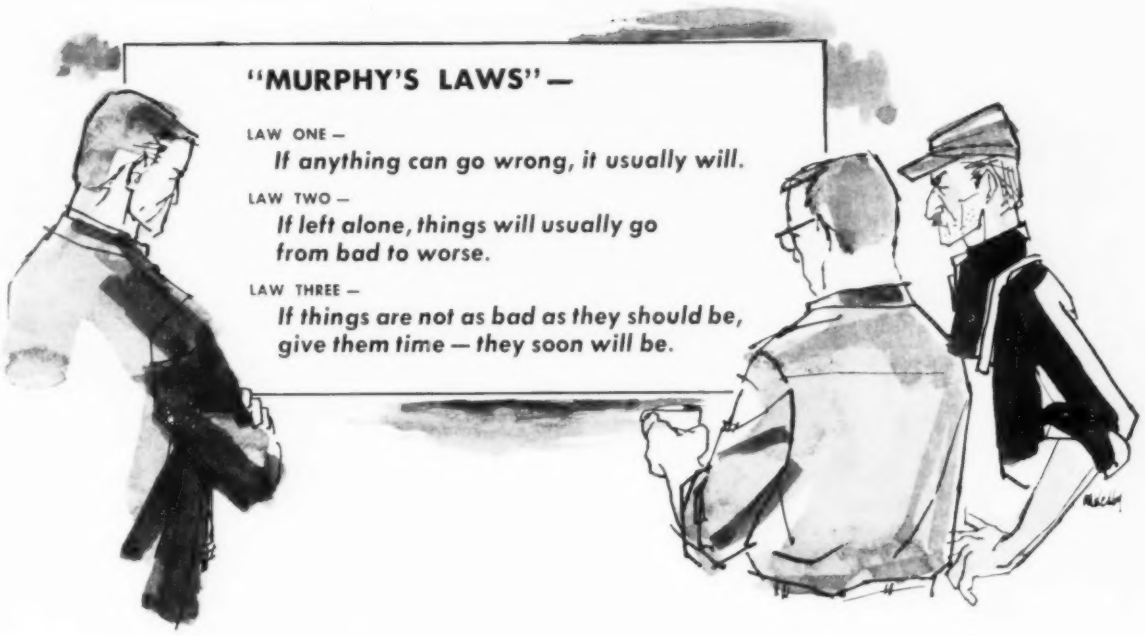
Ever-Tites can do a *better* job because they are better engineered. To make a good tight connection just slip the coupler over the adapter and close the handles.

In every operation that calls for couplings it pays to standardize on EVER-TITE. Ask your distributor for full details.

Brass • Aluminum • Stainless Steel • Malleable Iron

Other materials available on request

EVER-TITE COUPLING CO. INC.
254 West 54th Street, New York 19, N. Y.


"MURPHY'S LAWS"—
LAW ONE—
If anything can go wrong, it usually will.
LAW TWO—
If left alone, things will usually go from bad to worse.
LAW THREE—
If things are not as bad as they should be, give them time—they soon will be.

Murphy's Laws Mean Trouble

SOME weird things go on around here. Probably the best description of our usual state of affairs is what some joker has labeled "Murphy's Laws":

Law 1—If anything can go wrong, it usually will.

Law 2—If left alone, things will usually go from bad to worse.

Law 3—If things are not as bad as they could be, give 'em time—they soon will be.

Take our gas compressor plant. We have four big gas-engine-driven compressors tied into the refinery gas system. The plant takes a polyglot of wet overhead vapors from several units and kicks the gas through a liquids recovery section before running dry gas into the yard fuel system.

These old compressors will just sit there, day in and day out, and pound away at that gas until the noise gets monotonous. You can hear that steady, fireless whooming all day and all night—and it's a mighty comforting sound, even if it is monotonous.

That's where we were last summer, in the middle of our last run. All the compressors were rocking right along when, for no apparent reason, Murphy's First Law went into action. We lost No. 2 compressor. Just kicked off in the middle of the afternoon.

This was unusual, but not a catastrophe—the operators got the spare on in plenty of time with no damage.

After the machine was back on, Dutch Kriger went over all the cutouts and checked the engine. Everything was working as it was supposed to. There wasn't much to do but leave it alone.

Right then, Murphy's Second Law went into motion. At about 10 o'clock, the same machine kicked off again.

Inside of an hour, Dutch had the place swarming with men—and Solly was swarming all over Dutch. They still couldn't find anything, so they put it back on just before noon.

About two-o'clock, the flares were popping again. We were well into Murphy's Second Law.

"Dutch, those lame-brained mechanics have got to find out what's shutting down those machines." Solly was doing back-flips by now. And I braced myself for Murphy's Third Law to take over.

Now about the worst thing that can happen to a refinery man—outside of dying on payday morning—is to get called out in the middle of the night. This is by way of saying that things were not yet as bad as they could have been.

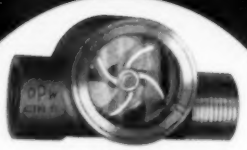
But that didn't last long either. That night at two in the morning, Solly was calling everybody in town. Why he called me I'll never know, but he was determined to make me share his misery.

"No. 2 compressor is down again." he screamed over the phone. I can't stay out here 24 hours a day wet nursin'

If you'd like a small reproduction of the artwork above, suitable for posting, just circle 80 on the Reader's Service Card on p. 232.

Takes one look to know what's going on inside your flow line with...

OPW VISI-FLO



No. 44

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OPW VISI-FLO sight glass indicators are a trustworthy visible means of alerting you as to rate of flow, viscosity, color of liquids, clarity, and purity of product.

OPW VISI-FLO protects you against line stoppage, helps maintain uniformity, a high standard of product quality and an even continuity of production.

WRITE FOR FREE BULLETIN F-6 describing complete VISI-FLO line, from plain types to magnetic indicating types.

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these damn compressors through this run—we gotta shut the plant down and find out what's wrong!"

Next morning, Solly looked ready for the DT ward—he'd had it. And when Solly is miserable, everybody else in sight is going to be miserable, too. When I came into the Bull Pen, he was still working on Dutch, so I slipped on through to the Old Man's office.

In a few minutes, the Old Man showed up with Solly hanging on his shirt-tail.

"How we gonna find what's wrong with that plant? We can't keep-a-watchin' everything there waitin' for something to happen again. You take a look at these operating charts and tell me what's wrong."

"Solly, don't bother me with operating charts. If you can't figure it out in three days, I'm not gonna try to do it in fifteen minutes. Bring me your shift charts, though—if the trouble is not mechanical, it's got to be human." Solly was as mystified as I was, but he got out the shift charts and laid them on the Old Man's desk.

"Now lemme get this straight," the Old Man said. "Monday, we lost No. 2 compressor at two in the afternoon, Tuesday the same machine at ten in the morning and two in the afternoon, and Wednesday night again—right?"

Solly nodded. "At two in the morning."

The Old Man was scanning the shift schedule. "See anything peculiar about your personnel schedule when you have your trouble?"

"No. Why? Watcha tryin' to say? That my operators don't know how to run that plant?"

"No, Solly. Keep yer shirt on—I'm not saying anything yet, but an old refinery man is a creature of habit. You'll notice that every time you have a shutdown, it happens at 10 and 2 on the day shift and around 2 AM on graveyard."

"So?" Solly and I were both curious now.

"What is an operator likely to be doing at 10 and 2 on the day shift?"

"Probably making coffee."

The Old Man rocked out of his chair. "Right. Now let's go down and see what's stopping that machine."

"Okay," Solly said, "but you're up the wrong tree this time."

Well, Dutch, Solly, and I watched while the Old Man sniffed around the plant. First he checked the coffee warmer behind the control board. Then into the compressor room. Back there was another steam coil coffee warmer used mostly for mechanics and engine room operators.

"Solly," the Old Man said condescendingly, "follow that ½-in. steam line and I think you'll have your answer."

"What the hell does this little ol' steam line have to do with that machine—it's just for a steam coil."

"Just follow the line."

We all traced the line back to the low pressure header on the outside of the building, then started back. The line was one of those typical bootleg jobs that get sneaked in on all units. It ran alongside the lube oil piping for about four feet.

"Now, Solly," the Old Man said, "just figure out what happens at coffee time around here. Whenever the operator opens that steam line to heat his water for coffee, he is steam tracing your lube oil piping for a short distance just upstream of the shutdown thermocouple. Reason it won't register on your charts is you've got a separate thermocouple for the recorder. If you don't get that pipe moved away from the oil piping you'll have a bunch of nuts for operators—can't think of anything more frustratin' than to have a compressor shut down at coffee time every day."

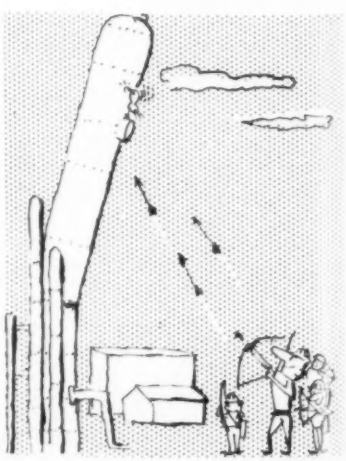
Solly went off like a Roman candle. "Dutch, get a gang of pipefitters over here and clear out these damn steam lines. If these operators want coffee, they'll have to bring it in a bottle. There'll be no more coffee making on my units from now on."

"Hell, Solly, no need in that—just move the line—that's all ya have to do."

"Get 'em outa here. I don't want 'em on my units, I tell ya!"

Next month, the boys continue their lessons in the facts of refinery life

• • •



Do You Know These Words?

By B. H. WEIL

A regular department intended to help administrators and operating men keep abreast of technical names and processes in the petrochemical field.

Methyl butynol

Methyl butynol, pronounced **"meth**-il **beu**-tin-ohl," is one of the newer petrochemicals, being derived by the catalytic reaction of acetylene and acetone. A colorless liquid, it freezes and boils at temperatures close to those of water, but is lighter in weight than water per unit volume. It is a flammable substance and has the formula $HC{\equiv}C\text{-}C(OH)\ (CH_3)_2$. This formula reveals its unique status; methyl butynol is an acetylenic alcohol, containing both an acetylenic group ($HC{\equiv}C\text{-}$) and an alcohol radical ($\text{-}OH$).

Methyl butynol is finding commercial use as a stabilizer for chlorinated organic compounds, as a special solvent, and—more particularly—as an intermediate for the synthesis of flavors, pharmaceuticals, perfumes, and specialty monomers.

The intermediates for the manufacture of methyl butynol—acetylene and acetone—are both petrochemicals. Acetylene is now being produced commercially by the high-temperature cracking of natural gas and/or petroleum hydrocarbons (in addition to production from coal-derived calcium carbide). Acetone is a derivative of propylene (which comes from refinery cracked gases and/or the deliberate cracking of petroleum fractions), being produced commercially from isopropyl alcohol (as an intermediate), or from cumene (isopropylbenzene) in a process which also co-produces phenol.

Since methyl butynol is such a new petrochemical, commercially, its future remains to be determined. Its chemical composition guarantees it some attention, however.

Styrene

Styrene, pronounced **"sty**-reen," is one of the real tonnage petrochemicals. It came to the fore in World War II, both as one of the raw materials for synthetic rubber (the "S" in GR-S) and as the monomer (basic unit) in polystyrene plastics. It is a clear, colorless liquid with an aromatic odor, slightly lighter than water per unit volume, and it readily polymerizes to a solid when heated or exposed to light or a peroxide catalyst. It has the formula $C_6H_5\text{-}CH{=}CH_2$; that is, ethylene in which one hydrogen atom has been replaced by a benzene group. Its reactions are chiefly based on those of its versatile "vinyl" ($\text{-}CH{=}CH_2$) unit.

As mentioned above, styrene finds its chief uses as a raw material (along with butadiene) for the manufacture of the "S" types of synthetic rubber—the types now in common use—and as the building block for the versatile polystyrene plastics. Styrene is also copolymerized with butadiene to yield the biggest selling of the latex paints (see PETROLEUM PROCESSING, Jan., 1955, p 82).

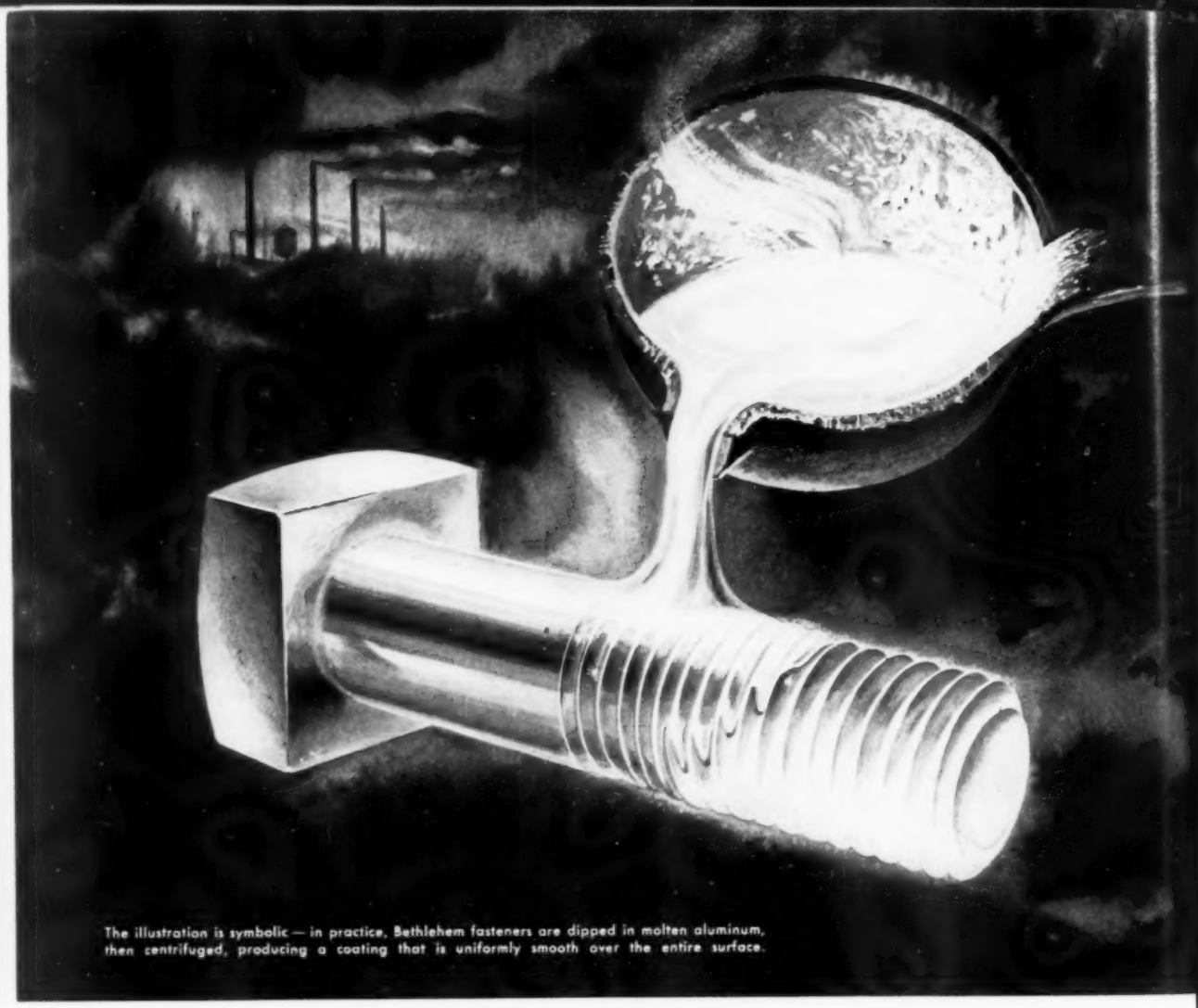
Styrene is a true petrochemical, being produced from ethylbenzene, itself a reaction product of benzene (which is from the catalytic reforming of naphthas) and ethylene (from refinery cracked gases and/or the deliberate cracking of propane, gas oil, etc.). Ethylbenzene itself also occurs in some catalytic reformates, and attempts to separate it commercially have been reported. To yield styrene, the ethylbenzene ($C_6H_5\text{-}CH_2\text{-}CH_3$) is then catalytically dehydrogenated.

Production of styrene seems certain to increase, tied as it is to the growing demand for its chief products. However, increased competition for the "S" types of synthetic rubbers—from Butyl rubber, and perhaps from the isoprene rubbers—may soon slow somewhat the galloping pace of styrene production forecast a few years ago.

Mr. Weil is chief editor of Esso Research and Engineering Co.'s technical information division, Linden, N. J. He was until recently with Ethyl Corp.'s research and engineering department.

NEWS in VIEWS

BRIGHT FREELOADERS fatten up on choice gull food at Tidewater's Delaware Refinery. Local seagulls now punctually assemble for each shift cleaning of the pumping-station riverwater screens and help keep things neat.



The illustration is symbolic — in practice, Bethlehem fasteners are dipped in molten aluminum, then centrifuged, producing a coating that is uniformly smooth over the entire surface.

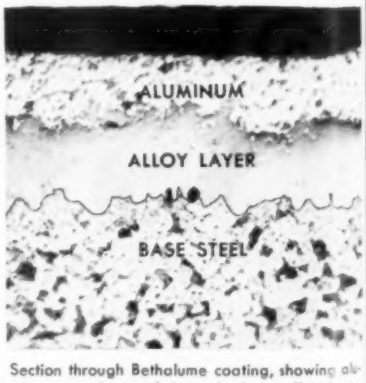
Bethalume Coating for Fasteners is Superior in Corrosive Atmospheres

All too frequently, corrosive atmospheres take a heavy toll of steel fasteners used in refineries. But not when fasteners are protected against corrosion by Bethlehem's Bethalume coating—the hot-dip aluminum coating—which, under identical exposure, outlasts zinc in most corrosive atmospheres.

With Bethlehem's new coating facilities, fasteners for refinery service can be coated with a smooth layer of long-lasting, corrosion-resistant aluminum. Even with this coating, the threads are clean and sharp, thus permitting fast, easy assembly.

When fasteners are intended for use at elevated temperatures up to 1600 F, they can be heat-treated immediately after the application of the aluminum coating. The iron-aluminum alloy thus created on the steel surface provides additional resistance to heat-corrosion.

If you would like to know more about Bethlehem's Bethalume coating for fasteners, and the long service life it makes possible in corrosive atmospheres, just get in touch with the nearest Bethlehem office.



Section through Bethalume coating, showing aluminum overlay and iron-aluminum alloy layer.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
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BETHLEHEM STEEL

BETHLEHEM STEEL

Rules for Construction of Unfired Pressure Vessels

Ever since the first edition was published in 1925, the A.S.M.E. Boiler and Pressure Vessel Code has been an important reference for designers of steel vessels. To standardize rules for constructing unfired pressure vessels used only in refineries, a joint ASME and API committee was formed in 1931. The first result of this committee's work was a Code for Unfired Pressure Vessels published in 1934.

Until the beginning of 1957, designers of refinery vessels could consult later editions of each of the above codes. But, effective on January 1, 1957, there is now only one code to guide the design of unfired vessels. This is "ASME Boiler and Pressure Vessel Code Section VIII—Unfired Pressure Vessels." The joint API-ASME code has been discontinued.

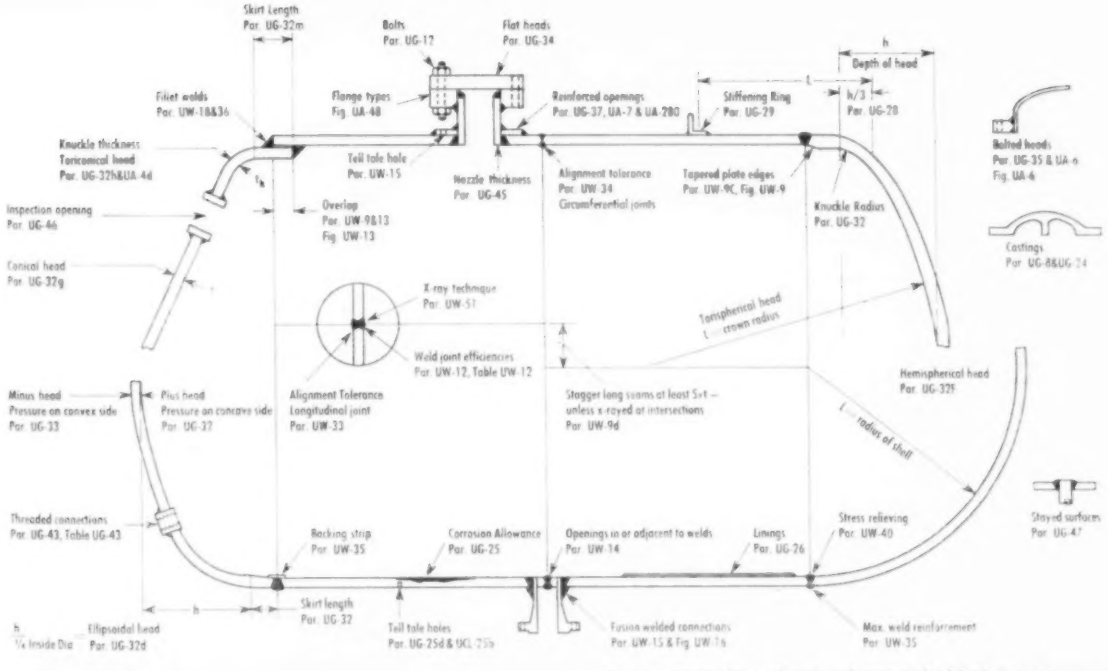
As with any code that is the result of years of experience and development, this new 195-page publication contains a tremendous amount of information. For someone using the code every day, there may be little difficulty in finding what he wants. But for the designer, fabricator or inspector who consults it infrequently, specific information may be difficult to locate.

To assist those wishing to find specific information quickly in this large fund of specifications and recommendations, the descriptive index below will prove helpful. This at-a-glance index quickly identifies specific questions and tells where in the code the answer will be found. It has been prepared by Mr. Robert Chuse and is based on his 20 years experience in approving A.S.M.E. Code design. It is reprinted with his permission from his copyrighted book, "The Unfired Pressure Vessel Code Simplified."

On the back of this sheet is a simplified chart for determining the required plate thickness for cylindrical pressure vessels as defined in the A.S.M.E. code. It also is taken from Mr. Chuse's book. Although the chart is based on a stress value of 13750 psi and 80% joint efficiency, pressure vessels designed with other stress values and joint efficiencies can be calculated easily from the same chart. Conversion factors for this one-step adjustment are presented with the chart.

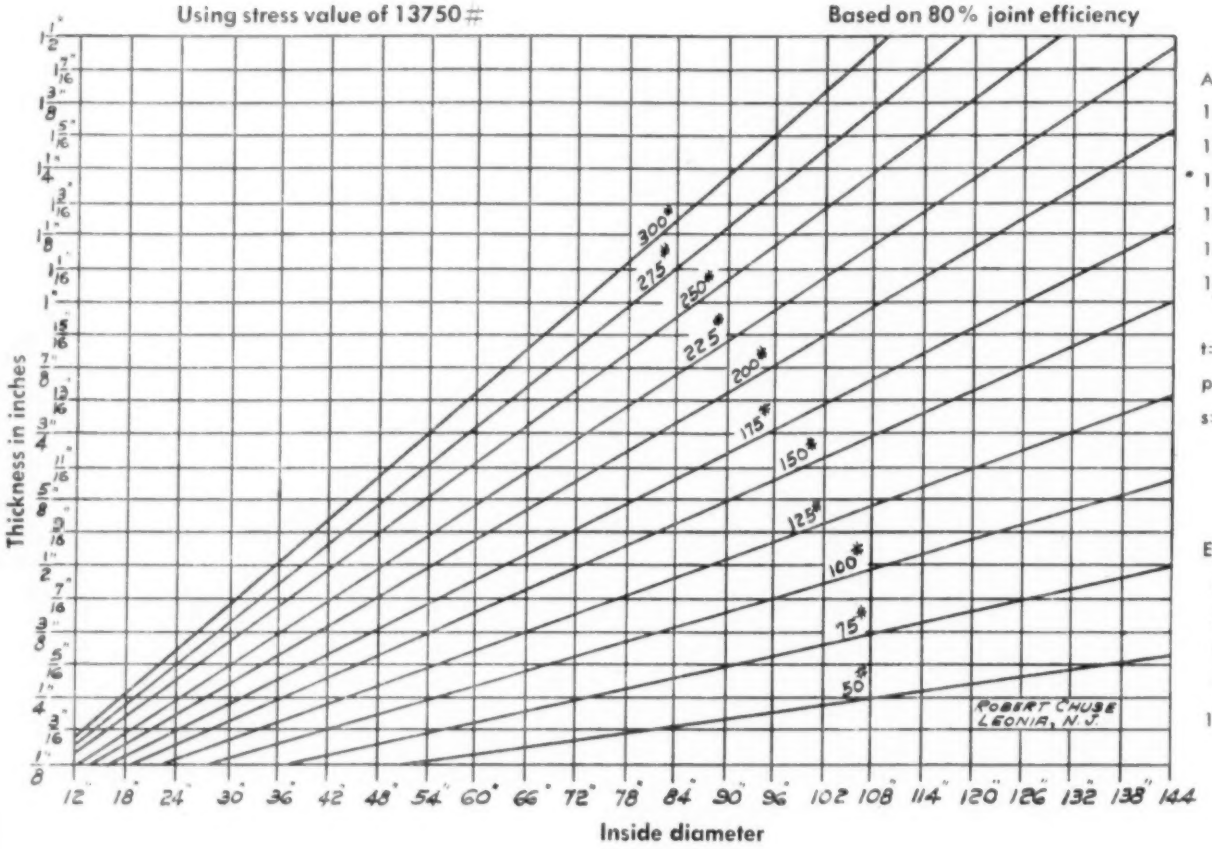
Larger working charts of either the *Descriptive Reference to the Code* or the *Cylindrical Shell Thickness Chart for Pressure Vessels* may be obtained by writing directly to Robert Chuse, P. O. Box 91, Leonia, N. J. Copies of this EDS 19 may be ordered from PETROLEUM PROCESSING.

Descriptive Reference to A.S.M.E. Unfired Pressure Vessel Code
by ROBERT CHUSE


Skirt Length Par. UG-32m
Bolts Par. UG-17
Flat heads Par. UG-34
h Depth of head
Fillet welds Par. UW-18&36
Flange types Fig. UA-48
Reinforced openings Par. UG-37, UA-7 & UA-280
Stiffening Ring Par. UG-29
h/3 Par. UG-28
Bolted heads Par. UG-35 & UA-6 Fig. UA-6
Knuckle thickness Toriconical head Par. UG-32h&UA-4d
Tell tale hole Par. UW-15
Nozzle thickness Par. UG-45
Alignment tolerance Par. UW-34 Circumferential joints
Tapered plate edges Par. UW-9C, Fig. UW-9
Knuckle Radius Par. UG-32
Inspection opening Par. UG-46
Overlap Par. UW-9&13 Fig. UW-13
Castings Par. UG-8&UG-24
Conical head Par. UG-32g
X-ray technique Par. UW-51
Tonspherical head L = crown radius
Weld joint efficiencies Par. UW-12, Table UW-12
Hemispherical head Par. UG-32f
Minus head Pressure on convex side Par. UG-33
Plus head Pressure on concave side Par. UG-32
Alignment Tolerance Longitudinal joint Par. UW-33
Stagger long seams at least 5xt — unless x-rayed at intersections Par. UW-9d
L = radius of shell
Threaded connections Par. UG-43, Table UG-43
Backing strip Par. UW-35
Corrosion Allowance Par. UG-25
Openings in or adjacent to welds Par. UW-14
Linings Par. UG-26
Stress relieving Par. UW-40
Stayed surfaces Par. UG-47
Skirt length Par. UG-32
Tell tale holes Par. UG-25d & UCL-25b
Fusion welded connections Par. UW-15 & Fig. UW-16
Max. weld reinforcement Par. UW-35
h 1/4 Inside Dia
Ellipsoidal Head Par. UG-32d

Turn page for chart of vessel thicknesses . . .

Cylindrical Shell Thickness for Pressure Vessels



For stress values other than 13750#

Allowable stress	Constant
11250#	multiply chart thickness by 1.222
12500#	multiply chart thickness by 1.1
15000#	multiply chart thickness by .9167
16250#	multiply chart thickness by .846
17500#	multiply chart thickness by .7857
18750#	multiply chart thickness by .733

t = thickness
p = pressure
s = allowable stress value
e = efficiency of longitudinal joint
r = inside radius

$$t = \frac{pr}{se - 0.6p}$$

For efficiency other than 80%

Efficiency	Constant
64%	multiply chart thickness by 1.25
85%	multiply chart thickness by .941
90%	multiply chart thickness by .889
95%	multiply chart thickness by .842
100%	multiply chart thickness by .8

Corrosion allowance for carbon & low alloy steel vessel, used for air, steam or water. Add 1/16" or 1/6 thickness (use smaller value). No corrosion allowance necessary when built to par. UW52b

Petroleum Processing Clip·n·File ENGINEERING DATA SHEET NO. 19

YOU'RE UP, Mr. OILMAN!

Here's your chance to make a hit with your friends and neighbors!

Because you are an oilman, all eyes will be on *you* during Oil Progress Week—October 13 to 19. It's the week when oilmen everywhere report to the nation on the progress made in their industry.

Oil Progress Week also gives you a great opportunity to create good public relations in your community for yourself and your industry—and the Oil Information Committee has much to offer to help you.

Here are some suggestions

Attractive, professionally-prepared materials are available for you to use in your community—films and speeches for radio and TV, window posters, exhibits and demonstrations, plus a complete ad mat proof book with ads that *any* oilman can use. This well-rounded community relations program contains everything you'll need to help you win prestige and friends.

One of the best ways to get started is to contact your local Oil Information Committee Chairman. He will help you plan a program that will work for you in your community.

So, team up to make Oil Progress Week —*your week*—a big success. Clip out and mail this coupon today!

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I want to take part in promoting Oil Progress Week in my town. Please send me your *free* booklet explaining Oil Progress Week activities and listing the materials available to me.

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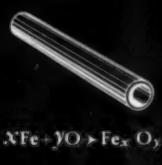
(To obtain more data on advertised products see page 230)

PRESSURES

TEMPERATURES



OXIDATION

CORROSION RESISTANT

SIZE

At B&W—You Can Get - - - The Right Tube For The Job

Pressures, temperatures, oxidation, corrosion resistance, and tube size are important factors the design engineer must consider in specifying tubing for process equipment applications.

For example, one company was faced with a serious problem. Stainless tubing used for conveying methanol and unreacted synthesis gases at 300F and 5000 psi through chloride-bearing bayou water failed due to stress corrosion.

What did they do?

Just what many other companies have done—they called in Mr. Tubes, a B&W Tube Representative. He suggested B&W Croloy 5 as the best material for the job.

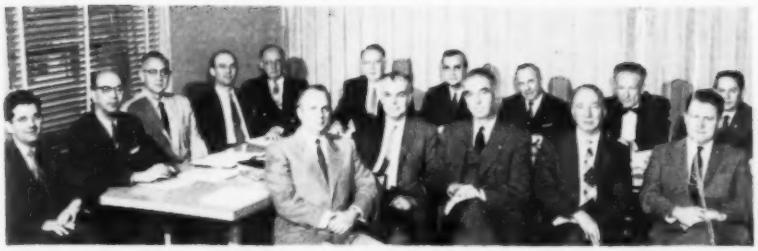
The new tubing provided the desired resistance to the particular type of corrosion and satisfactorily met all temperature and pressure requirements. What's more, the new installation proved to be substantially lower in materials costs.

B&W, with its years of experience in all phases of tube requirements, is especially qualified to help you choose the right tubing for any job. To get the most benefit from B&W's long experience in matching tubes to jobs in every respect, call on Mr. Tubes, your nearby B&W Tube Representative. He has helped others, as he can help you, make tubing selection *surer*. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

TA-7010-PP4

Seamless and welded tubular products, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels

PERSONALS



API Research Project 45 advisory committee and others (identified below)

New chairman for API Project 45

NEW chairman of the API Research Project 45 advisory committee is Dr. E. C. Hughes, Standard Oil Co. (Ohio), who succeeds Dr. Wheeler G. Lovell, Ethyl Corp. In the above picture, taken at a recent committee meeting, when the change was made, eight of the 10 members are shown, plus associate directors of the Project and members of advisory committees for related API projects. Unless otherwise identified, the men are members of the Project 45 advisory committee.

Left to right, along the wall:

E. J. Scott, Socony Mobil Oil Co.,

Louis Schmerling, Universal Oil Products Co.,

J. M. Derfer, Ohio State University, associate project director,

K. W. Greenlee, Ohio State, associate project director,

C. E. Boord, Ohio State, director of the project,

E. C. Hughes, Standard Oil Co. (Ohio),

W. G. Lovell, Ethyl Corp.,

L. C. Beard, Jr., Socony Mobil,

G. H. Denison, California Research Corp.,

R. A. Randall, General Motors Corp.,

Front row, left to right:

L. L. Stout, Ohio State University Research Foundation,

E. O. Mattocks, API,

S. S. Shaffer, Humble Oil & Refining Co., member of a related project advisory committee,

F. E. Frey, Phillips Petroleum Co.,

N. D. Coggeshall, Gulf Research and Development Co., member of a related project advisory committee.

Project 45 has just completed knock-testing of 368 pure hydrocarbons and is now studying to find the principles for predicting the knock of pure hydrocarbon mixtures.

J. S. Boylan, chief fire marshal and director of safety and security for Continental Oil Co., has been given a certificate of appreciation by the American Petroleum Institute in recognition of his 25 years of service on accident-prevention and fire-protection committees.

The award was made at the recent midyear meeting of the Safety and Fire Protection Committees of the API.

Dr. W. B. Franklin, of Humble Oil & Refining Co., has joined the advisory council for the newly formed Engineering Foundation of the University of Texas, College of Engineering. The Foundation seeks to improve facilities and recognition for the engineering faculty, students and alumni. Franklin is acting manager of the refining technical and research division in Humble's executive development program.

C. E. Davis, petroleum consultant and former refining vice-president of Shell Oil Co., has been elected a director of Commerce Oil Refining Co. He will be on its executive committee and act as part-time consultant on construction and operation of the company's projected refinery at Jamestown, R. I.

O. P. Puryear has been appointed assistant manager, laboratory operations, technical services division, of the Texaco Research Center at Beacon, N. Y. He was formerly regional manager of the technical services division at Houston.

He joined Texaco in 1927, after taking a B.S. degree in chemical engineering from Texas A. & M. College.

George E. Tillquist has joined Sinclair Chemicals, Inc., as process engineer. He was previously with Sinclair Research Laboratories and is now located in New York.

Tillquist was graduated from Northwestern University with a bachelor's degree in chemical engineering. He began with Sinclair in 1951.

Two administrative positions have been created to coordinate management of Sinclair Refining Co.'s manufacturing department. The job of manager of planning has been taken by **R. E. Howe,** formerly manager of processing and before that head of the Sinclair, Wyo., refinery.

The post of manager of operations has been filled by **E. W. Griscom,** who was manager of the East Chicago, Ind., refinery.

Howe will coordinate the department's activities with the research and chemical subsidiaries of Sinclair. Griscom will coordinate the long-range problems of the operations group. In matters of personnel and labor relations he will also assist W. V. Ischie, general manager of manufacturing.

New manager at East Chicago is **George A. Blaine,** who was assistant manager.

John S. Patchin retired recently from Atlantic Refining Co. after 37 years of service. He was assistant plant manager of the Philadelphia refinery.

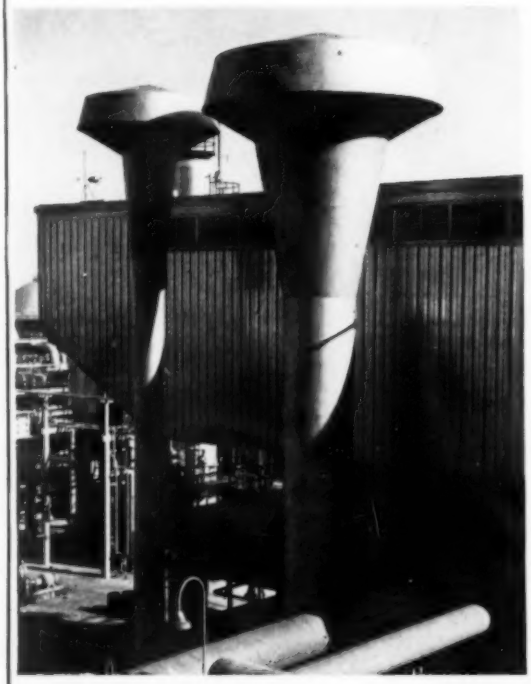
A graduate of New York University, Patchin joined Atlantic in 1920. In 1942 he was named head of the refinery's lubricating department, in 1950 superintendent of the mechanical department, and in 1952 he was made assistant manager of the refinery.

Cecil E. Carson, a director of Imperial Oil Co. Ltd., has been elected vice-president of the Chemical Institute of Canada for 1957-58.

Stanley T. Reynolds has been named manager of the Calgary refinery of Imperial Oil Co. He succeeds **J. J. Hanna,** who has retired after serving at the refinery since 1922. Reynolds has been plant superintendent at the Edmonton refinery for the past four years.

Norman T. Robey has been named assistant manager of the Whiting re-

AT TIDEWATER'S NEW DELAWARE REFINERY



AIR INTAKE DUCTS TO CAT CRACKER COMPRESSION SECTION
66 inch duct in foreground
30 inch duct in back

Philadelphia Iron Works fabricated the following lines and ducts for Tidewater Oil Company's new Delaware Refinery.

Monel overhead line

Cold coke transfer line

Hot coke transfer line

66 inch diameter main air blower intake ducts

30 inch diameter air blower intake duct

Gasoline splitter overhead line

Fractionator overhead line for the fluid coker

Condenser to receiver duct—and various other ducts

Engineers • *Contractors* • *Manufacturers*

PHILADELPHIA IRON WORKS

INCORPORATED

D STREET ABOVE ERIE AVE.

PHILADELPHIA 24, PA.

STEEL CHIMNEYS • STEEL TANKS • FABRICATED PIPE

finery of Standard Oil Co. (Ind.). He succeeds **C. G. Daugherty,** who retired recently. **Delmer G. Debo,** formerly superintendent of the mechanical division at Whiting, succeeds Robey as assistant manager of the Casper, Wyo., refinery.

Arthur B. Kent has been appointed chief chemist at Sun Oil Co.'s Marcus Hook refinery. He succeeds **George E. Reese,** who has retired. Since January he has been a special assistant to the superintendent of refining. In his new post he is head of the laboratory.

Charles C. Martin, crude oil coordinator at the refinery, has won a Sloan fellowship for a year's study at Massachusetts Institute of Technology.

R. P. Medlin has been appointed chief process engineer in the technical department of Magnolia Petroleum Co.'s Beaumont refinery. He succeeds **B. J. Schulz,** who has transferred to the New York headquarters of Socony Mobil Oil Co. as coordinator of lubricants and allied products.

Medlin has been succeeded as assistant chief process engineer of planning and coordinating by **E. J. Reeves.**

D. Glenn Morgan, recently retired director of research and development for D-X Sunray Oil Co., has been retained by the Western Petroleum Refiners Association as consulting technologist. Morgan, who completed 40 years service in the refining industry recently, has served with various technical committees of the Association, as well as the American Petroleum Institute, Society of Automotive Engineers and others.

Mr. Morgan

Promotions have been announced at Humble Oil & Refining Co.'s Baytown, Texas, refinery:

J. F. Mathis to section head and **C. T. Shewell** to senior research specialist. Both are in the research division.

L. A. Bullington to technical specialist in the technical service division,

R. A. Dreselly, A. R. Dudley, and **R. F. Pfennig** to section head in technical service,

T. M. Babin and **D. C. Seamans** to senior project engineer; **H. A. Bordelon, J. R. Samway** and **R. H. Walton**

(To obtain more data on advertised products see page 230)

1

NIAGARA FALLS, N. Y.
50% and 73% Liquid (in tank cars)

6 reasons why Mathieson CAUSTIC SODA is always there

2

SALTVILLE, VA.
50% and 73% Liquid (in tank cars)
76% Solid, Flake, Granular, and Ground (in drum shipments)

. . . an Olin Mathieson plant is near you.

. . . your source of supply is constantly backed up by five other plants.

For specifications and schedules, call your Olin Mathieson sales representative.

3

HUNTSVILLE, ALA.
50% and 73% Liquid (in tank cars)
50% Liquid (in barges)

4

BRUNSWICK, GA.
50% Liquid (in tank cars and barges)

5

McINTOSH, ALA.
50% and 73% Liquid (in tank cars)
50% Liquid (in barges)

6

LAKE CHARLES, LA.
50% and 73% Liquid (in tank cars)
50% Liquid (in barges and tankers)
76% Solid and Flake
(in drum shipments)

MATHIESON

MATHIESON CHEMICALS
OLIN MATHIESON CHEMICAL CORPORATION
INDUSTRIAL CHEMICALS DIVISION • BALTIMORE 3, MD.

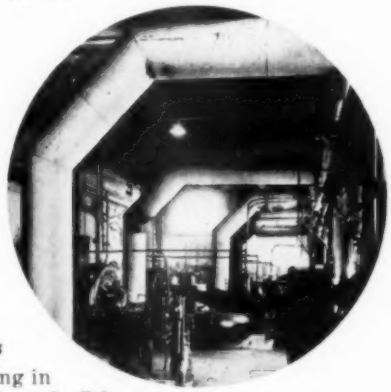
INORGANICS: Ammonia • Bicarbonate of Soda • Carbon Dioxide • Caustic Potash • Caustic Soda • Chlorine • Hydrazine and Derivatives • Hypochlorite Products • Muriatic Acid Nitrate of Soda • Nitric Acid • Soda Ash • Sodium Chlorite Products • Sulfate of Alumina • Sulfur (Processed) • Sulfuric Acid

ORGANICS: Ethylene Oxide • Ethylene Glycols • Polyethylene Glycols • Glycol Ether Solvents • Ethylene Dichloride • Dichloroethylether • Formaldehyde • Methanol Sodium Methylate • Hexamine • Ethylene Diamine • Polyamines • Ethanolamines • Trichlorophenol • Surfactants

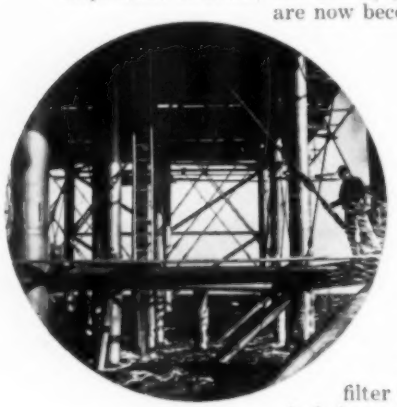
4920

How Monel pays off in equipment exposed to salt solutions

. . . pays off in pumps At Caloil's Perth Amboy refinery, this pump supplies 40,000 GPM of brackish cooling water. To counter the severe corrosive and erosive conditions, its shaft sleeves and 2200-lb. impeller are Monel* nickel-copper alloy. Monel alloy is a money-saver in seawater pumps.

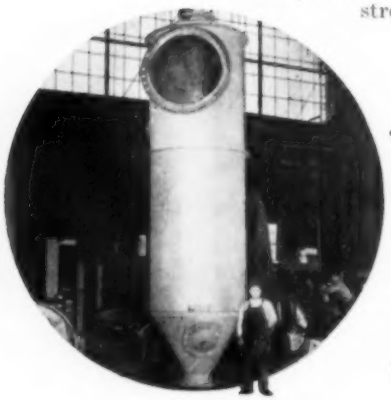


pays off in piping . . . In this California refinery, lightweight Monel lines proved able to handle salt water years longer than cast iron. This experience has been duplicated so often, Monel alloy piping, fittings, and valves are now becoming standard for such service.



. . . pays off in structurals The value of Monel alloy sheathing in preventing splash-zone corrosion of offshore structures like this is well-known. A less spectacular but equally valuable use is for plant structurals subject to salt splash, spill or atmospheres . . . tank supports, for example, or just plain nuts and bolts.

pays off in process vessels . . . These Sharples Super-D-Hydrators filter sodium sulfate crystals, wash them in brine and then dry them. Monel alloy provides just the needed properties for parts . . . . top-notch resistance to both corrosives, strength to handle high centrifugal forces, excellent fabricability.



. . . pays off in heat exchangers, condensers This barometric condenser is now in service at a large eastern sugar refinery. It features a Monel Clad Steel shell and solid Monel alloy internals. This construction has proved so effective in resisting the corrosive attack of brackish bay water that the refinery has standardized on Monel.

If your equipment for handling seawater and salt solutions is deteriorating faster than it should, an evaluation of Monel alloy in the application may prove helpful. Write Inco's Development and Research Division. *Registered trademark

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall Street, New York 5, N. Y.

INCO Nickel Alloys

Monel ... *for minimum maintenance*

Personals (continued)

to senior mechanical engineer; **L. D. Olafson** to senior maintenance engineer. All are in the engineering division.

H. G. Boynton, E. W. Lewis and **J. R. Miller** to senior research chemical engineer in the research and development division.

Fred W. Macfarline has joined Vickers Petroleum Co.'s Potwin, Kan., refinery as chief refinery engineer. He was formerly maintenance supervisor for Great Northern Oil Co.

Raymond S. Gibson has taken the newly created post of senior process engineer at the refinery.

A graduate of the University of Oklahoma, Macfarline holds a degree in civil engineering. Among his previous jobs he has worked at Blaw-Knox Co. and Deep Rock Oil Co.

Gibson received a chemical engineering degree from Kansas State College. He has been with Vickers since 1951.

J. P. Jones, of Bradford, Pa., has been elected president of the Pennsylvania Grade Crude Oil Association. **Glenn E. Scott,** vice-president of Wolf's Head Oil Refining Co., has been elected assistant treasurer.

Re-elected officers are as follows: **George J. Hanks,** president of South Penn Oil Co., first vice-president,

A. C. Simmons, Simmons Oil Co., second vice-president,

Fayette B. Dow, Washington, D. C. vice-president and general counsel,

Samuel Messer, Quaker State Oil Refining Corp., treasurer,

C. L. Suhr, South Penn Oil Co., and **C. G. Johnson,** Quaker State, assistant treasurers,

W. C. Wenzel, executive manager.

E. W. McNealy has been named assistant general superintendent of the Port Arthur refinery of The Texas Co. He was previously superintendent of the Lockport, Ill., works.

H. A. Lord, superintendent of the Lawrenceville, Ill., plant, has been named superintendent at Lockport.

Ray Powell, superintendent of special assignments in the New York office, has been appointed superintendent at Lawrenceville.

Harry A. Logan, Jr., has been elected president of United Refining Co. **Fred G. Bannerot, Jr.,** has been made chairman of the board. Logan is the son of Harry A. Logan, Sr., who was president of the firm until his recent death.

Bannerot is also president of Elk Refining Co., Charleston, W. Va.

RESCO

CASTABLES LINE THE WORLD'S LARGEST REFINERY VESSELS

. . . Tidewater's Delaware Refinery

Tidewater Oil Company's new Delaware Refinery has six of the largest refining vessels in the world. The Orthoflow fluid catalytic cracking unit is capable of processing 102,000 barrels per day. In the center of the photograph is the 42,000 barrel-per day fluid coker.

Complete refractory lining of Orthoflow fluid catalytic cracking unit, fluid coker and cyclones was supplied by Refractory Specialties Company. These vessels were lined with RESCO CAST RS-3 insulating and RESCO CAST RS-15 high strength castables. The cyclones were lined with a special erosion-resistant castable, RESCO CAST RA-22.

The Refractory Specialties Company is proud to have had a part in this project. We salute the Tidewater Oil Company on its successful completion and operation of the plant.

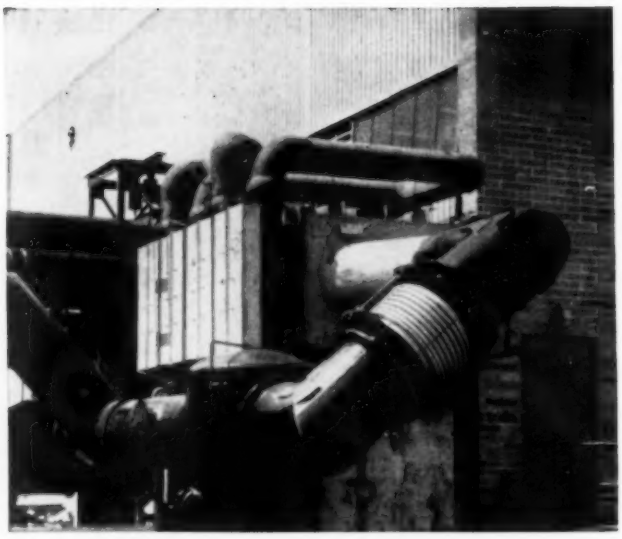
When you have a refractory problem, why not consult Refractory Specialties engineers. They have a refractory to meet every application and their experience in the field is unsurpassed. Contact them today.

CASTABLES - MORTARS

PLASTICS - LADLE BRICK

REFRACTORY SPECIALTIES COMPANY

2200 Washington Ave. · Philadelphia 46, Pa.



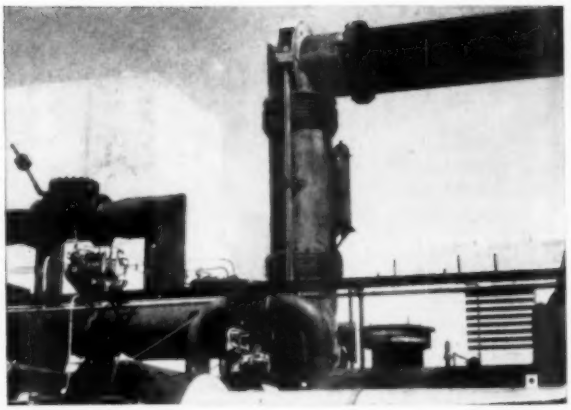
SPECIAL EXPANSION JOINTS

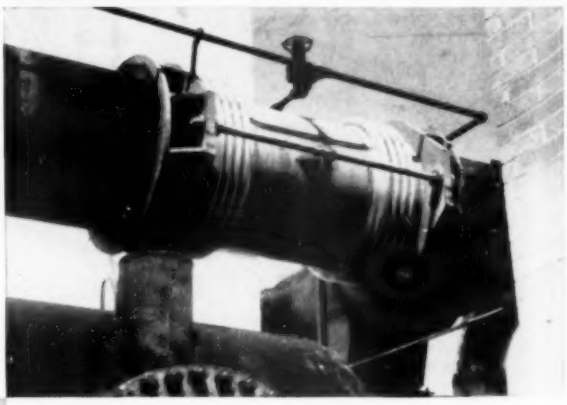
are Second Nature to ADSCO

These photographs show installations of special ADSCO Corruflex Expansion Joints at the Fairchild Engine Division, Fairchild Engine & Airplane Corp., Deer Park, Long Island, N. Y. All joints are designed to absorb lateral motion only, except that the long universal joint, right center, also absorbs any axial growth of its own. All joints are equipped with internal sleeves to smooth out the flow of high-temperature air being carried by the piping systems. They are not standard joints; they are specially engineered, specially manufactured.

A few years ago, when ADSCO was pioneering packless joints for special work, a job like this took considerable engineering and manufacturing time... because it was a new field. But since then, ADSCO has acquired so much experience from so many special orders that special jobs like the Fairchild one are truly "second nature".

Special applications of packless joints are developed carefully but not laboriously. Experience enables ADSCO engineers to get the work out easily and with confidence. Consult them next time you have a special piping problem.





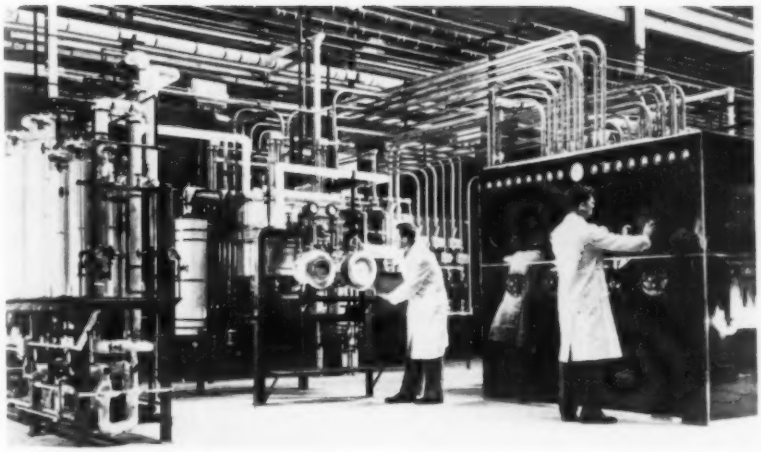
REMEMBER!

Use ADSCO Expansion Joints instead of Pipe Bends because of these advantages.

1. LESS HEAT LOSS
2. LESS PRESSURE DROP
3. LESS SPACE
4. LESS COST

AMERICAN DISTRICT STEAM DIVISION
YUBA MANUFACTURING COMPANY
20 MILBURN ST. BUFFALO 12, N. Y.

(To obtain more data on advertised products see page 230)



DELAYED COKER PILOT PLANT at new engineering development center of Lummus Co. in Newark, N.J. Tanks, heaters and pumps are at left, electrical control cabinets at right, and coker unit is in center. The 150,000-sq-ft facility supplements company's engineering lab at Bayonne and greatly enlarges its development services to the oil industry.

Greene made sales v-p for Crane

Joseph W. Greene, formerly director of industrial sales, has been elected vice-president of sales for Crane Co., manufacturer of valves, fittings, plumbing and heating equipment. He heads a realigned sales department, which coordinates industrial, plumbing and air conditioning sales efforts previously handled on a divisional basis.

Charles W. Lovelace, manager of Crane's valve and fitting department, has succeeded Greene as director of industrial sales.

Greene joined Crane as an industrial salesman in 1936. He served in various sales capacities in Houston, Chicago and New York. In 1954 he became eastern district manager, and two years later was made director of industrial sales.

Lovelace began with Crane in 1938, worked in oil industry sales at the Chicago office and at branches in Shreveport and Memphis. In 1947 he became assistant manager at Memphis and in 1954 manager in Detroit. In 1956 he was named manager of the valve and fitting department.

National Tube promotes two

Two appointments have been made in the management of U.S. Steel Corp.'s National Tube Division. William J. McKee, formerly general manager of sales, has been named assistant vice-president of sales. Robert E. Williams, who was director of distribution and availability of the parent firm, has been promoted to general manager of sales, succeeding McKee.

Beckman names chief engineer

Anthony Del Duca has been appointed chief electronics engineer for the process instruments division of Beckman Instruments, Inc. Formerly a senior engineer, he will direct the design of electronic circuitry in process instruments.

An electrical engineering graduate of Cornell University, Del Duca was previously with North American Aviation Corp.

Taylor names Nichols chief engr.

Nathaniel B. Nichols has rejoined Taylor Instrument Companies as chief engineer. He left the company several years ago to become professor of electrical engineering at the University of Nebraska and later joined Raytheon Manufacturing Co. as assistant vice-president and manager of commercial engineering.

He replaces Ralph E. Clarridge, who has been appointed to the president's staff as specialist for new product lines.

IBM adds to petroleum dept.

J. R. DeSilva has been appointed special representative in the petroleum department of International Business Machines Corp., covering the midwestern sales region. He will coordinate sales activities and planning of applications in the petroleum field.

Another job will be to conduct classes for customer personnel and seminars for IBM sales representatives. He joined IBM in a sales post in New Orleans and has served as accounting machine sales manager in Mobile, Ala. He is a graduate of Loyola University.

LaQue elected ASTM v-p

F. L. LaQue, vice-president of the International Nickel Co., has taken a second vice-president's job, with the American Society for Testing Materials. He was elected to the two-year term at the group's recent annual meeting in Atlantic City. LaQue has been Inco's manager of research and development since 1954. During the nine years previous to that he was head of the R&D division's corrosion engineering section.

LaQue has been a director of ASTM since 1955 and serves on several committees of the board.

Fleischer made Selas v-p

Kurt W. Fleischer has been elected vice-president of the fluid processing division of Selas Corp. of America. His new post includes engineering and sales supervision of Selas Constructors, Inc., Houston, as well.

Mr. Fleischer

Fleischer joined Selas in 1942 and took active part in creation of the fluid processing division. He co-developed the gradiation heater.

Fleischer is a member of the API.

Bassett made C&H president

Horace Y. Bassett, executive vice-president of Calumet & Hecla, Inc., has been elected its president and chief executive officer. He succeeds Endicott R Lovell, who has been named chairman of the board and of the executive committee.

Bassett began in industry as a metallurgist and a sales engineer. He was factory manager of the Wolverine Tube Co. when the company was purchased by C&H in 1942. He became general manager of the Wolverine

Easy, Quick to Install

. . . that's why using Glitsch Caps and Risers will allow your unit to go on stream with a minimum installation time. The removability feature also allows cleaning to be done either inside the tower or on the ground outside. The comparatively thin-gauge metal used in Glitsch assemblies cools off and heats up rapidly, which further reduces downtime.

Over the years, we have designed more than 300 different cap and riser assemblies for every process requirement. We can furnish virtually any conceivable type and design—opened- or closed-slot caps; set-on, swaged, or pull-up risers; with wedge, quarter-turn cap, or stud hold-downs. Either round or rectangular assemblies are available in a full range of sizes and materials.

If you would like more information on Glitsch Cap and Riser Assemblies, Glitsch Truss-Type® Trays, or other Glitsch products and services, call our nearest office or write to us at P. O. Box 6227, Dallas. There is no obligation, and you will be pleased with the prompt and competent recommendations our representatives will make for your project.

DALLAS • CHICAGO • CLEVELAND • HOUSTON LOS ANGELES • NEW YORK • TULSA • UXBRIDGE

Glitsch Bubble Caps

(To obtain more data on advertised products see page 230)

Tube division a year later, a vice-president in 1948, and executive vice-president in 1956.

ALCO appoints Cooley v-p

ALCO Products, Inc., has appointed Edward N. Cooley vice-president in charge of thermal products and the petroleum industry equipment divisions. He joined ALCO's predecessor, American Locomotive Co., in 1920, rose through the company's accounting department, and became assistant comptroller of the Montreal Locomotive Works in 1947. After further promotions he became assistant to the president and then, in 1956, director of administrative services as part of a company decentralization move.

Mr. Cooley

Personnel changes

Procon Incorporated — Oliver E. Auer to the sales staff. A chemical engineering graduate of Washington University, St. Louis, he was formerly senior sales engineer of Girdler Co.'s gas processing division.

Oil Well Supply Div.—Howard Rainbird to area manager, tubular sales, at Edmonton, Alta.; James M. Reid to assistant district manager of the Oklahoma district; Gordon C. Shay, Jr., to manager of the Pampa, Texas, store; Harold S. Tipton to manager of the Sundown, Texas, store, succeeding Richard E. Yates, who has been transferred to Monahans, Texas; Paul L. Mallow has been transferred from Williston, N.D., to Farmington, N.M.; Benjamin F. McIntosh has been transferred from Sherman, Texas, to Wichita Falls, Texas.

Chicago Bridge & Iron Co.—Richard D. Ayers to the Chicago sales office.

Wolverine Tube Div.—George E. Reade to sales representative in the Chicago area. He was formerly supervisor of wholesaler sales in Detroit.

De Laval Steam Turbine Co.—Paul S. Nurko to general superintendent of all production shops; Leonard Schwarz to superintendent of the main shop; Kenneth Lippincott to superintendent of the standard products shops; Mil-

Suppliers (continued)

ton Hammond to superintendent of the turbocharger shops; Joseph Basso to supervisor of manufacturing research. Changes were made to expand the supervisory team of the manufacturing division.

Cooper-Bessemer Corp.—R. F. Kymer to assistant chief engineer of the products division; M. J. Helmich to assistant chief engineer of the development division; Arthur Abel, Jr., to district manager of the Tulsa office; C. L. McDougall to branch manager at Odessa, Texas, succeeding Arthur Abel, Jr.; Frank J. Hunter to branch manager in the St. Louis and Kansas City areas; Charles L. White has retired as district manager of the north central states area after 28 years with the company; T. L. Freeman to the Los Angeles office as sales engineer; John O. Fighter to the company's international operations.

Rockwell Manufacturing Co.—Charles N. Perry to factory manager of the new Porterville, Calif., plant. He has been purchasing agent for the Oakland plant for the past 5½ years.

Ever-Tite Coupling Co., Inc.—Roy W. Gronauer to midwestern manager and sales engineer, with headquarters in Cincinnati. He was formerly sales vice-president of the OPW Corp.

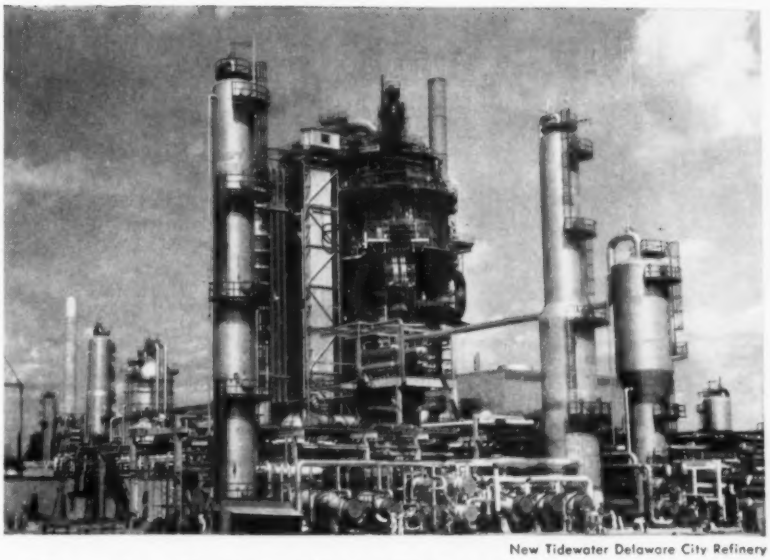
Chemical Construction Corp.—John F. Babbitt to sales engineer in the New York office.

Mason-Neilan Division—Eric. A. Bianchi to vice-president of engineering; Paul Wing, Jr., to chief engineer. Bianchi was formerly director of engineering; Wing was manager of the product application engineering department.

Fischer & Porter Co.—Nathaniel Brewer, from vice-president of research and development, to vice-president in charge of technology and chairman of the executive committee; Alexander Greenfield succeeds him as research director. Greenfield was formerly with Daystrom, Inc., as director of research and development.

Stauffer Chemical Co.—Philip H. McLaughlin to manager of sales administration at the New York office; Martin P. Kerins to sales manager of industrial national accounts.

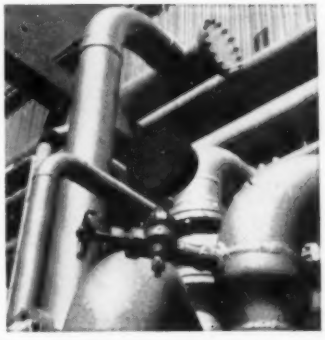
Houdry Process Corp.—Royes Salmon to the engineering department as senior process engineer. He was pre-



New Tidewater Delaware City Refinery

For the Outstanding Refinery of the Year
The Choice Was

JERGUSON INSTRUMENT VALVES and LIQUID LEVEL GAGES



New 66UVG Instrument Valves with Vertical Rising Ball Check

Jerguson Reflex Type Liquid Level Gages

For this magnificent new example of modern efficiency in refinery design and construction, the engineers chose Jerguson Instrument Piping Valves for their field mounted pressure gages, as well as Jerguson Liquid Level Gages and Valves. Throughout the plant you will find hundreds of dependable Jerguson Gages and Valves.

The new Jerguson 66UVG Instrument Valves are used in scores of places throughout the plant . . . the unique valves which have a vertical rising ball check and make it possible to eliminate the usual block valve. These valves speed construction and servicing because they combine the valve, unions, nipples, reducers, elbows, tees, valve and bleed valve in one package . . . a space saving unit with a great reduction in threaded connections.

Liquid level measurement throughout the refinery is handled efficiently by dependable Jerguson Liquid Level Gages and Valves.

You too will find you can rely on Jerguson Gages and Valves to serve your many needs, for new construction or replacement.

Ask for catalog sheets on Jerguson 66UVG Valves and Liquid Level Gages.

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

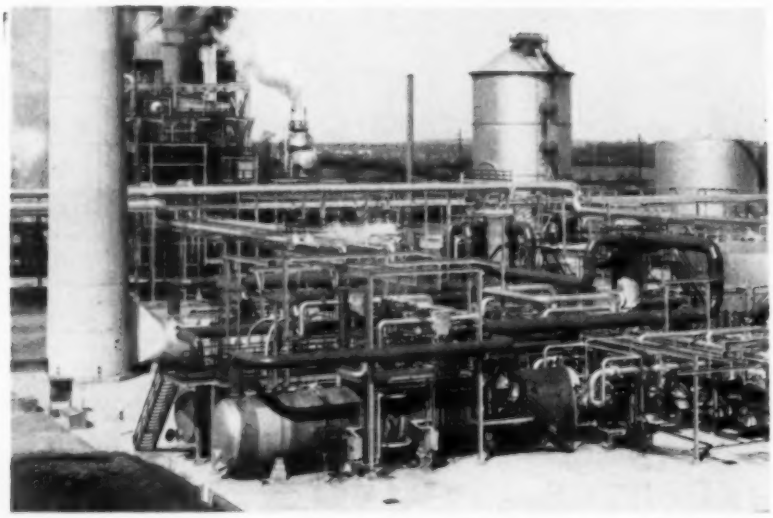
JERGUSON GAGE & VALVE COMPANY

Offices in Major Cities **100 Adams Street, Burlington, Mass.**

Jerguson Tress Gage & Valve Co., Ltd., London, England, Pétrole Service, Paris, France

(To obtain more data on advertised products see page 230)

BREECHING and DUCTWORK ARE CONNERY'S BUSINESS



Partial view of the sulfur recovery unit at Tidewater Oil Company's new Delaware Refinery

Connery supplied the ducts and breeching for the sulfur recovery unit at Tidewater Oil Company's "Refinery of the Future".

We are Designers and Fabricators of—

Breeching
Forced and induced draft ducts
Recirculating ducts
Coal hoppers and pipe
—from carbon, stainless and stainless clad steels
Multiple expansion joints of all types
—from carbon and stainless steels
Pressure doors

Write for new brochure

75 Years of Experience in

Design – Engineering – Fabricating

CONNERY CONSTRUCTION COMPANY

4000 North Second Street

Philadelphia 40, Pa.

Suppliers (continued)

viously with Union Oil Co.'s research center in Brea, Calif. Earlier he was with Foster Wheeler Corp. in New York.

Bailey Meter Co.—Frank H. Hollows to manager of the chemical and petroleum sales division.

Wolverine Tube Division—Del E. Wessels to technical sales representative in Oklahoma and north Texas areas. Howard J. Luetzow to technical sales representative in Chicago and surrounding area. Both men were formerly with the Detroit sales office.

Branches, distributors

Consolidated Electrodynamics Corp. has opened district sales offices in Orlando, Fla., and St. Louis, Mo. Richard C. Wynne heads the Orlando office, and Joseph W. Ashley is field engineer in charge of the office at St. Louis.

Blaw-Knox Co. will combine its New York and Philadelphia sales offices into a new eastern regional sales office at Haddon Heights, N.J. Company has also opened a small office at 230 Park Ave., New York City, for customers in the immediate area. Move to New Jersey will be completed by August 15.

Delta Tank Manufacturing Co. has established a New York sales office at 122 E. 42nd st. This is Delta's first office in the northern U.S. and is directed by Louis J. Persbacker.

Davison Chemical Co. has named Canadian distributors for its silica gel for natural gas dehydration. Company is Commercial Chemicals Co., a division of Standard Chemicals, Ltd.; its headquarters are in Vancouver with branches in Calgary and Edmonton.

Expansion, transition

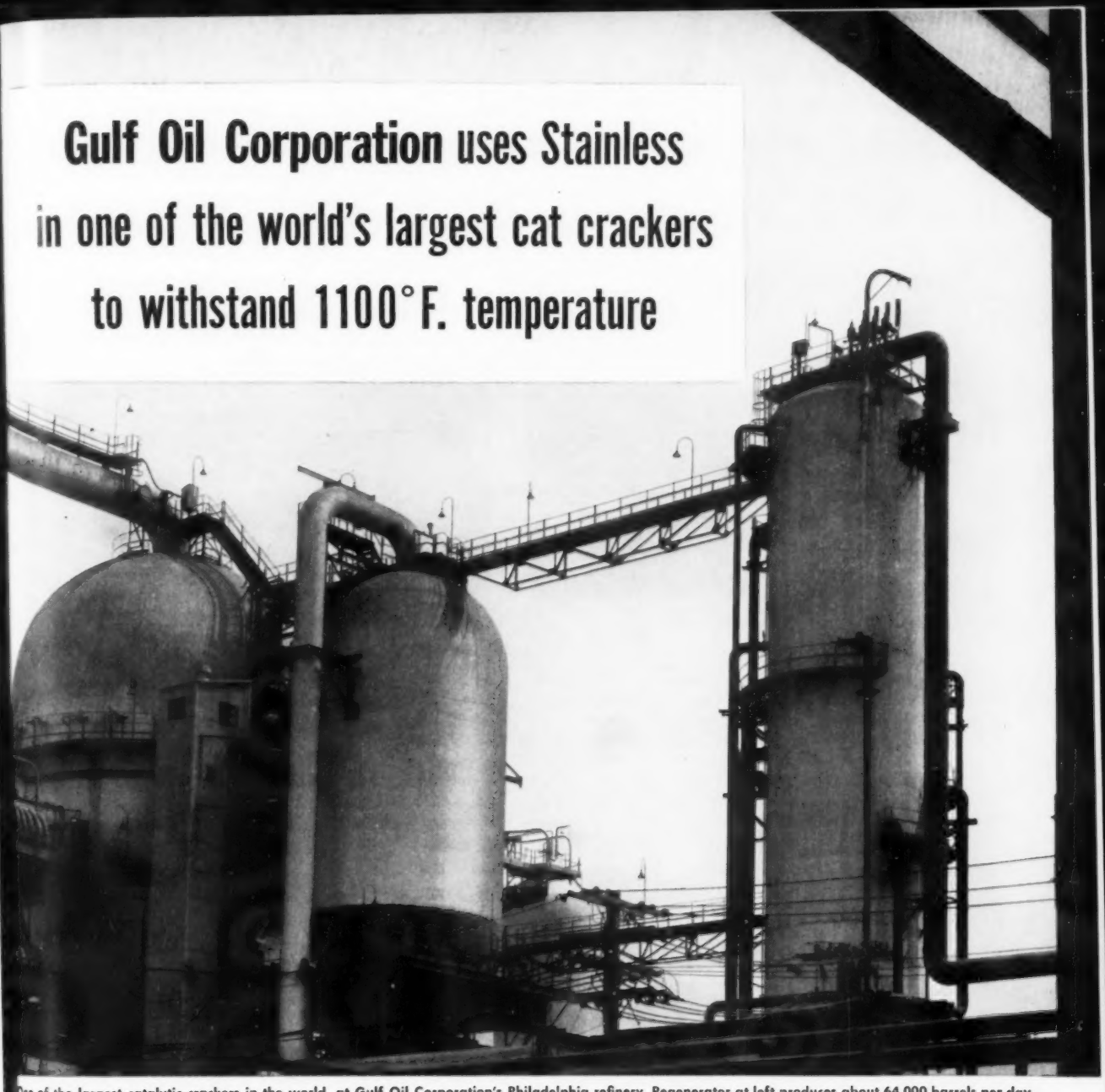
Ethyl Corp. will build a distribution terminal for antiknock compounds at Everett, Wash. Completion is expected this summer.

Western Plastics Corp., Hastings, Neb., has quadrupled its manufacturing capacity of plastic pipe since early in 1956.

Carrier Corp. will absorb the Elliott Co., maker of steam turbines, electrical equipment, heat transfer apparatus, and other industrial process equipment. Elliott, a Jeannette, Pa., firm will continue as a division.

(To obtain more data on advertised products see page 230)

Gulf Oil Corporation uses Stainless in one of the world's largest cat crackers to withstand 1100° F. temperature



One of the largest catalytic crackers in the world, at Gulf Oil Corporation's Philadelphia refinery. Regenerator at left produces about 64,000 barrels per day.

IN ITS PHILADELPHIA REFINERY, Gulf operates one of the world's largest catalytic cracking units. It produces high octane gasoline, heating oils, fuel gas, gas oil, propane-propylene and butane-butylene. Capacity is about 64,000 barrels per day. 9 million pounds of catalyst circulate each hour, and the unit consumes nearly 400,000 pounds of steam per hour.

The top of the spherical regenerator is shingled with 14-gage Stainless Steel strip. Temperature reaches about 1100° F. in the burning atmosphere, and the Stainless Steel shingles resist erosion caused by the pressure circulation of the catalyst, which has the consistency of talcum powder. Carbon steel shingles would deteriorate and fail rapidly. Bottom section and cone of the fractionating tower (right) are lined with Stainless Steel to withstand corrosion at high (700° F.) temperature.

Stainless Steel gives you the most for your money when it is designed *into* equipment, right from the start. So think of Stainless Steel when you design. Think of *USS* Stainless when you buy.

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO · NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALABAMA
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS STAINLESS STEEL

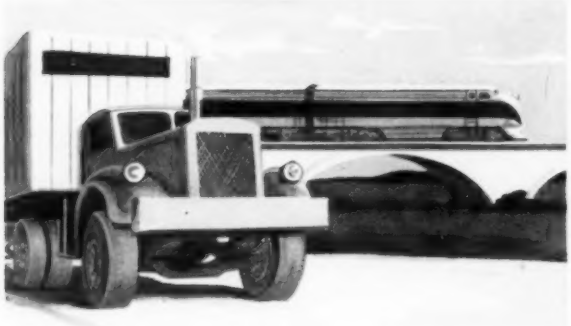
SHEETS · STRIP · PLATES
BARS · BILLETS
PIPE · TUBES · WIRE
SPECIAL SECTIONS

UNITED STATES STEEL

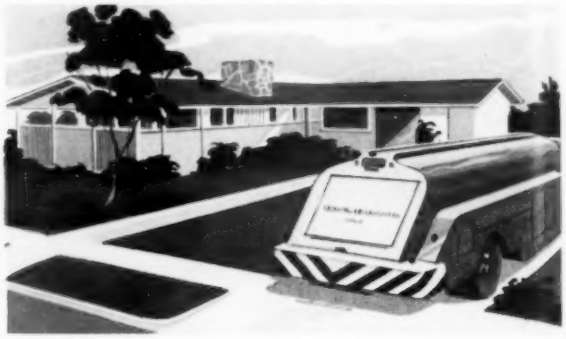
Improved fuel oil performance means . . .
BIGGER PROFITS IN EVERY MARKET

AUTOMOTIVE • RAILROAD • MARINE • INDUSTRIAL AND HOME HEATING

Diesel, residual, or heating **. . . whatever the grade of oil, problems peculiar to each can be solved with Du Pont Fuel Oil Additive No. 2 (FOA-2).**



DIESEL • The excellent dispersant action of FOA-2 improves a diesel fuel's filterability—thus minimizing sludge-caused injector-sticking and filter-plugging. Du Pont FOA-2 is a stabilizer as well as a dispersant. By stabilizing cracked distillates, it helps to overcome incompatibility between blends of cracked and straight-run stocks. Another point—being nonmetallic and ashless, FOA-2 does not contribute to sparking from diesel locomotive stacks.



IN HOME HEATING • As a stabilizer and dispersant, FOA-2 prevents sludge formations that cause filter-fouling and nozzle-plugging. It also minimizes ignition failures—its nonmetallic *ashless* feature means no deposits to foul the operation of the electrical system. Thus, it helps eliminate many service calls that cost you money. FOA-2 retards the formation of insoluble residues during storage, too . . . so the oil remains free-flowing and clean-burning.

RESIDUAL • Even small amounts of FOA-2 can prevent sludge formation in tanks and on burner parts. Its outstanding *dispersancy* action removes sludge that has already accumulated. As a result, Du Pont FOA-2 helps to create many more customers and more *satisfied* customers—for residual fuels.

●

With this one additive you acquire definite, demonstrable sales advantages. For more information about Du Pont FOA-2, contact your nearest Du Pont Petroleum Chemicals office.

SALES OFFICES

Chicago 3—8 So. Michigan Ave. . . . RAndolph 6-8630 • **Cleveland 15**—25 Prospect Ave. . . . SUperior 1-1363 • **Denver 2**—510 Mile High Center Bldg. . . . AComa 2-2347 • **Houston 2**—705 Bank of Commerce Bldg. . . . CApitol 5-1151 • **Los Angeles 17**—612 So. Flower St. . . . MAdison 5-1691 • **New York 20**—1270 Ave. of the Americas . . . COlumbus 5-2342 • **Philadelphia 2**—3 Penn Center Plaza . . . LOcust 8-3531 • **Pittsburgh 22**—1 Gateway Center . . . ATlantic 1-2933 • **San Francisco 4**—111 Sutter St. . . . EXbrook 2-6230 • **Seattle 3**—4003 Aurora Ave. . . . MElrose 6977 • **Tulsa 1**—1811 So. Baltimore Ave. . . . LUther 5-5578 • **In Canada**—Du Pont Company of Canada (1956) Limited, Petroleum Chemicals, 85 Eglinton Ave. East, **Toronto 12**—Ontario . . . HUdson 1-6461 • **In Other Countries**—Petroleum Chemicals Division, Export Sales, 7447 Nemours Bldg., Wilmington 98, Delaware . . . OLympia 4-5121, Extension 2962.

DU PONT
REG. U.S. PAT. OFF.

Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & CO. (INC.)—Petroleum Chemicals Division, Wilmington 98, Delaware

 (To obtain more data on advertised products see page 230)

Industry watches Government claim for . . .

Goodrich's Ameripol SN

THE Government's suit against B. F. Goodrich Co. (PP, June '57, p. 10), seeking to force Goodrich to give the Government all technical information plus a royalty-free license on Goodrich's Ameripol SN "synthetic natural rubber," raises questions about rights and duties under Government research contracts. In legal terms, the outcome of the case has real significance for companies engaged in their own research while at the same time they are working in a related field under a Federal research grant.

Hard core of the Government's case is that the synthetic rubber research contract Goodrich had with the Government from 1949 to 1955 requires Goodrich to turn over its new process because: 1) the synthetic itself is within the scope of the research contract, and 2) such information is necessary to make use of other information the Government was otherwise entitled to have under the contract.

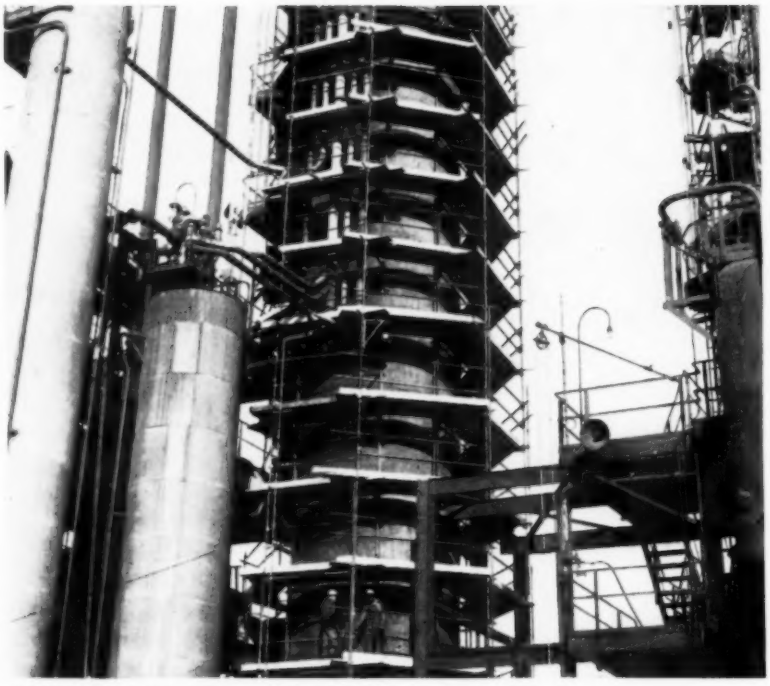
Goodrich claims its new synthetic process was discovered and developed independently of, and outside the scope of, the Government contract, and has refused to make any of the technical information available despite repeated Government demands.

THE FOLLOWING PATENTS are selected from the Official Gazette of the U. S. Patent Office for Apr. 23, 30, Vol. 717, Nos. 4,5; and May 7, 14, 21, Vol. 718, Nos. 1,2,3. Copies of patents are available for 25¢ each. Order by patent number from the Commissioner of Patents, Washington, D. C.

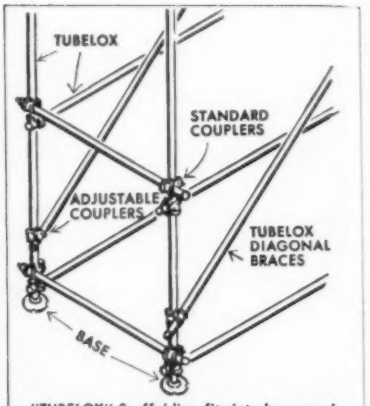
Processes and Methods

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT NO.
Alkylation	aromatics	dilute aq. soln. of strong acid	California Research Corp.	2,793,239
	phenol	acrylonitrile	Union Carbide & Carbon Corp.	2,789,995
Breaking	petroleum emulsions	oxyalkylation products	Petrolite Corp.	2,792,351-73
	petroleum emulsions	organic ester & oxysilane	Visco Products Co.	2,790,777
Cat crack. & desulf.	hydrocarbon mixture	single, multi-zone reactor	Socony Mobil Oil Co., Inc.	2,791,544
	sulfur-containing oils	liquid phase reaction	Gulf Research & Development Co.	2,791,546
Cat cracking	heavy oil	2-stage H_2 donor diluent process	Esso Research & Engrg. Co.	2,791,541
Cat dehydrogenation	liquid hydrocarbons	gamma alumina catalyst	Houdry Process Corp.	2,790,015
Cat reforming	naphthas	platinum-containing catalyst	Shell Development Co.	2,792,337
Chlorination	methane	Cl_2-CH_4CCl_4	Diamond Alkali Co.	2,792,435
Coating	wet metal surfaces	plastic-asbestos material	The Texas Company	2,793,138
Coking	heavy petroleum oils	integrated desulfurization	Esso Research & Engrg. Co.	2,793,172
	heavy residuals	fluidized-mass system	Esso Research & Engrg. Co.	2,791,547
Control	foaming	phosphorous-containing defoamants	Socony Mobil Oil Co., Inc.	2,792,374
Conversion	hydrocarbons	fluid, platinum-containing cat.	M. W. Kellogg Co.	2,791,542
	hydrocarbons	pebble heater process	Phillips Petroleum Co.	2,791,545
	mercaptans	disulfide formation	Standard Oil Co. (Ind.)	2,792,334
	petroleum naphthas	cat reforming & hydrofining	British Petroleum Co. Ltd.	2,792,333
Cross-linking	fluoro-olefin polymers	polyalkylene polyamines	M. W. Kellogg Co.	2,793,200
Deasphalting	residual oils	wash oil to remove metals	Esso Research & Engrg. Co.	2,793,167-8
Decobalting	Oxo aldehydes	aging and water extraction	Jefferson Chemical Co., Inc.	2,790,007
Dehydrating	gas streams	adsorbent material	United Gas Corp.	2,790,505-512
Deodorization	benzene hexachloride	water-organic solvent	Ethyl Corp.	2,790,012
	gas streams	mico-biological growth	R. D. Pomeroy	2,793,096
Desulfurization	cracked gasoline	catalytic hydrogenation	Union Oil Co. of Calif.	2,793,170
	naphthas	adsorbing S with metallic Ag	Esso Research & Engrg. Co.	2,791,540
Dewaxing	mineral oils	dewaxing solvent	Shell Development Co.	2,793,169
Fluid cat cracking	petroleum hydrocarbons	control of slurry oil recycle quality	Gulf Research & Development Co.	2,790,753
Fluid coking	hydrocarbons	prevention of coke deposits	Esso Research & Engrg. Co.	2,793,173
	hydrocarbons	quenching of hydrocarbon vapors	Esso Research & Engrg. Co.	2,791,549
	hydrocarbon oils	comminuting & coke classifying	Esso Research & Engrg. Co.	2,789,942
Grease	inorg. colloid hydrogel	hydrophobic surface-active agent	Shell Development Co.	2,790,776
Hydrobromination	1-olefins	activated carbon	Pan American Petroleum Corp.	2,790,013
Hydrolyzing	C_2H_6-H_2SO_4 absorbate	liquid-vapor contactor	National Petro-Chemicals Corp.	2,792,432-3
Improvement	color stability	treatment of naphthenic acids	Sun Oil Co.	2,789,999
Maintenance	catalyst activity	cat make-up & cyclic regen.	Socony Mobil Oil Co., Inc.	2,791,543
Manufacture	acetaldehyde	acetylene-aqueous soln. react.	Taoka Dyestuff Mfg. Co. Ltd.	2,791,614
	acetylenes	electric arcs on liquid hydrocarbon feed	Pure Oil Co.	2,790,759
	activated carbon	petroleum acid sludge coke	Esso Research & Engrg. Co.	2,790,511
	activated coke	steam and carbon dioxide	Esso Research & Engrg. Co.	2,790,781-2

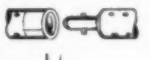
Continued on p. 215



"TUBELOX" SCAFFOLDING assembles quickly for work on alkylation tower.



"TUBELOX" Scaffolding fits into bases and is erected quickly with standard and adjustable couplers for vertical, horizontal, and diagonal members. Any size, shape or height scaffold can be made with *only four basic parts*, all galvanized.



"TUBELOX" members 6' to 20' long, 2" and 2½" o.d., which interlock for continuous lengths.

STANDARD COUPLERS for right angle connections

ADJUSTABLE COUPLERS for diagonal connections

BASES to spread loads on first vertical members

Saving Turn-Around Time

How one large refinery does it with "TubeLox" Scaffolding

SAVING turn-around time for refinery maintenance and repair duty is an all-important factor. Many hours can be saved if scaffolding and work platforms are provided that can be erected, dismantled and moved with the utmost speed, efficiency and safety.

A large midwestern oil company uses "TubeLox"® Steel Scaffolding because it performs as required. It makes no difference what the turn-around jobs are—cracking, cooling or crude distillation towers; pressure vessels; heat exchangers; tanks, valves or piping—"TubeLox" Scaffolding works perfectly for all.

This versatile, all-purpose scaffolding, galvanized throughout to resist corrosion, is unlimited in its ability to conform to almost any shape, size or height encountered. There are virtually no obstructions which can not be overcome with "TubeLox" Scaffolding . . . even inside of tanks.

Towers and associated piping can be scaffolded with "TubeLox" Scaffolding to provide working platforms at any desired levels. It is fireproof and requires only a minimum amount of wood for staging. The strong, slender members offer little wind resistance and can be combined with "TubeLox" Aluminum End Frames, with built-in ladders, for extra light-weight, easily-handled rolling or stationary scaffolds of medium height.

Another important consideration given to "TubeLox" Scaffolding by this refinery is the fact that all components are 100% recoverable after each use and provide many years of practical, economical service.

"Trouble Saver"® Sectional Steel Scaffolding with standard frames varying from 3' high x 5' wide to 6'6" x 5', together with pivoted, diagonal braces, are often used for intermediate rolling or stationary platforms in refinery maintenance. "Gold Medal"® Midget and Junior Safety Swinging Scaffolds suspended by steel cables help in speeding the completion of light-duty repairs. The light-weight, ease-of-handling qualities of PS aluminum scaffolds save time and labor on many isolated turn-around jobs.

It would pay you to get the facts on how "TubeLox" and other PS Co. Scaffolding can help you save turn-around time. PS Co. offers complete nation-wide engineering service available locally. See the Yellow Pages in your telephone directory for the nearest Patent Scaffolding Co. office or representative that *sells* or *rents*" TubeLox" or "Gold Medal" Scaffolding.

For complete description and installation details . . . write for Bulletins PTS-18 and PTS-19.

FOR GREATER SAFETY...EFFICIENCY...ECONOMY

GOLD MEDAL LADDERS SCAFFOLDING

THE PATENT SCAFFOLDING CO., Inc.

38-21 12th Street Dept. PP Long Island City 1, N. Y.
West Coast: 6931 Stanford Ave., Los Angeles 1, Calif.
Branches in all principal cities
***In Canada:* 355 Dufferin St., Toronto**

(To obtain more data on advertised products see page 230)

Do you have a source of waste heat . . . from still bottoms, intermediate fractions, process liquids, or exhaust steam . . . that is not being put to useful work?

If so, refer the matter to the G-R Employment Office For Heat. This "employment agency" has found well-paying jobs for waste heat in refineries all over the country . . . to preheat incoming fluids, to heat other liquids, air, or gases, and to generate steam. G-R heat exchanger designs have successfully recovered heat even from tarry and dirty materials that have clogged previously used units, and they are materially reducing fuel costs and improving plant processes in many hundreds of refineries.

Your inquiry will receive prompt attention from the G-R engineers who have long specialized in solving heat transfer problems of every conceivable kind. Write for advice and specific recommendations on *your* waste heat problem.

THE GRISCOM-RUSSELL COMPANY

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

MASSILLON, OHIO

Griscom-Russell

HEAT TRANSFER APPARATUS

GR-371

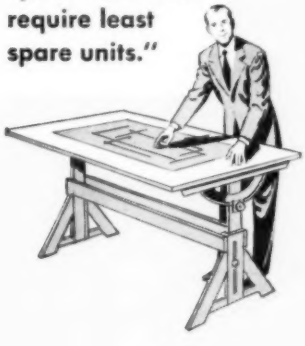
"Can you furnish an efficient heat exchanger for 2 fluids of different transfer rates?"

"I need a stock design of heat exchanger for quick shipment."

"Is it possible to get a heat exchanger with fins and tubes of different materials?"

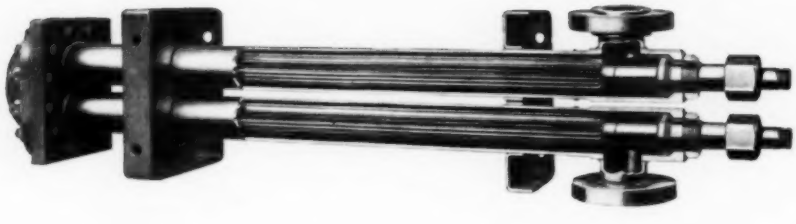
"Do you have a standardized heat exchanger that can be used for a variety of services?"

"I want a heater system that will require least spare units."



FIVE QUESTIONS
One Answer...

THE G-R TWIN G-FIN SECTION



Yes, this "Universal Heat Exchanger" meets all these needs . . . and many more. It actually has the widest range of heating, cooling, condensing and heat exchange applications of any heat transfer apparatus on the market. • The G-R Twin G-Fin Section has proved its effective design and durable construction through 25 years of service. • This unit is the simplest type of heat exchanger, easy to install, economical to maintain, and with high salvage value because of its standardized design. Write for bulletin describing the many Twin G-Fin Section advantages in detail.

THE GRISCOM-RUSSELL CO.

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

MASSILLON, OHIO

GR-374

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT NO.
Manufacture (cont'd)	alcohol	hydrog. of Oxo aldehyde bottoms	British Petroleum Co., Ltd.	2,793,236
	alcohols	hydrog. of olefin ozonides	Shell Development Co.	2,792,431
	aluminum salts	anion exchange resin	Universal Oil Products Co.	2,791,486
	ammonium phosphate	NH_3-phosphoric acid reaction	Union Oil Co. of Calif.	2,792,286
	benzoic acid	oxid. of subst. cyclohexanes	Phillips Petroleum Co.	2,792,419
	bituminous mixtures	road building qualities	J. H. Grunewald	2,793,139
	carbon black	pyrolizable carbonzeous material	M. Steinschlaeger	R 24,315
	color carbon black	reduced viscosity of suspensions	Deutsche Gold- und Silber-Scheidenstalt	2,793,101
	cyclopentene	cyclopentadiene hydrogenation	Esso Research & Engrg. Co.	2,793,238
	high-grade coloring black	gas-generating disintegrant	Deutsche Gold- und Silber-Scheidenstalt	2,793,100
	hydrocarbon wax	methanol & cobalt catalyst	Du Pont Co.	2,793,241
	hydroxyphenyl alkanes	separation from reaction prods.	Shell Development Co.	2,791,616
	liquid polymer oil	butadiene-styrene-ether reaction	Esso Research & Engrg. Co.	2,791,618
	lube oil	cracking of non-lube oil, gas oil feed stock	Shell Development Co.	2,790,754
	phenolic compounds	conversion of aromatics	Shell Development Co.	2,792,430
	phthalic anhydride	heat-removal of bound water	Mid-Century Corp.	2,789,988
	sulfenyl dithiocarbomates	alkyl sulfenyl halide reaction	Phillips Petroleum Co.	2,792,394
	water-gas & aromatics	pebble reactor cracking	Phillips Petroleum Co.	2,791,548
Nitration	aromatics	separation of waste acid	Du Pont Co.	2,791,617
Oxidation	hydrocarbons	nitric acid	Gulf Research & Development Co.	2,791,598
	mercaptans	activity control of Cu reagent	Phillips Petroleum Co.	2,790,008
	methylcyclohexane	potassium carbonate solution	Phillips Petroleum Co.	2,790,004
Polymerization	acrylonitrile	reduction-oxidation cat system	American Cyanamid Co.	2,793,199
	ethylene	alkali metal hydride & oxide cat	Standard Oil Co. (Ind.)	2,791,575
	styrene oxide	boron trifluoride	Standard Oil Co. (Ohio)	2,792,375
Production	asphalt emulsion	oleaginous material	Standard Oil Co. (Ohio)	2,789,917-8
Purification	crude alkyl ether	aqueous alkaline solution	Esso Research & Engrg. Co.	2,791,615
	hydrocarbon mixtures	removal of aromatics & sulfur	Pure Oil Co.	2,792,332
	petroleum distillates	removal of nitrogen & sulfur	Universal Oil Products Co.	2,790,751
Pyrolysis	hydrocarbons	single-pass cracker	Eastman Kodak Co.	2,790,838
Recovery	acids	solvent extraction of mixtures	National Distillers Products Corp.	2,790,002
	clean oil	rating of water-oil emulsion	Union Oil Co. of Calif.	2,793,193
	enriched gas mixture	selective solvent system	J. M. Hoff	2,792,903

Continued on p. 216

TAYLOR-WHARTON GAS TRANSPORTS

multiply the usefulness of bulk storage

If your operations require storage of compressed gases in bulk, it will pay you to put your storage facilities on wheels. The use of Taylor-Wharton Gas Transports enables you to move the supply to the point where it is needed at any particular time. Chemical, petrochemical, electronics and food processing companies operating their own gas producing plants, use these vehicles for inter-plant distribution of gases and for standby equipment.

Taylor-Wharton Gas Transports consist of specially constructed trailers in single and double axle models, mounted with a group of seamless steel storage pressure tubes made to ICC3A2400 specifications. The tubes are interconnected with valves and manifold to a common outlet in a weatherproof cabinet built on the rear of the trailer. Standard capacities range from 38,500 cu. ft. to 56,250 cu. ft. Other sizes as required.

Ask us for complete information, describing your requirements.

TW® **TAYLOR-WHARTON CO.** Division of HARSCO CORPORATION — Harrisburg 23, Pennsylvania

Patents (continued)

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT NO.
Recovery (cont'd)	oil	heat treat. of oil-bearing mineral	Texaco Development Corp.	2,793,104
	paraxylene	crystallization	Esso Research & Engrg. Co.	2,790,018
	tar sands oil	mulling & water separation	R. T. Eyre	2,790,750
	copper-vanadium catalyst	non-volatile mineral acid	Imperial Chemical Industries, Ltd.	2,791,566
Regeneration	spent alkylation H_2SO_4	electrolysis	Standard Oil Co. (Ohio)	2,793,182
Removal	catalyst contaminants	filtering cracker gas-oils	Esso Research & Engrg. Co.	2,789,695
	mercaptans	alkyl nitrite & peroxide	Universal Oil Products Co.	2,790,752
Testing	underground storage cavities	fluid of known density	The Texas Company	2,792,708
Segregation	aromatic hydrocarbons	alumina gel beds	Esso Research & Engrg. Co.	2,790,016
Separation	aromatics	antimony halide solution	Union Oil Co. of Calif.	2,793,240
	carbonylic compounds	distillation system	Shell Development Co.	2,791,550
	liquids	thermal diffusion	Gulf Research & Development Co.	2,791,332
	solid hydrocarbons	solvent & chilling	Shell Development Co.	2,791,539
Spraying	aluminum halide-hydrocarbon complex	improved method	Phillips Petroleum Co.	2,792,338
Stability improvement	cat cracked furnace oil	formaldehyde treatment	Standard Oil Co. (Ohio)	2,792,335
Stabilization	part. hydrog. hydrocarbon	phosphite ester	Monsanto Chemical Co.	2,790,014
Sweetening	straight-run heating oils	inhibitor system	Union Oil Co. of Calif.	2,793,171
Synthesis	aromatics	CO & hydrogen reaction	Standard Oil Co. (Ind.)	2,791,583

Products

Coating	food wrapping paper	heart-cut paraffin wax	Union Oil Co. of Calif.	2,791,569-70
Coloring material	carbon black	bentonite additive	J. M. Huber Corp.	2,793,134
Composition	diesel fuel	sulfonic acid lead salt, etc.	California Research Corp.	2,789,892
	sulfonate	high barium content	Standard Oil Co. (Ind.)	2,791,558
	turbine oil	mineral lube oil & additive	Gulf Oil Corp.	2,789,951-2
Conditioning	gasoline fuel system	mineral lube oil-alcohol-ketone-ester	Gulf Research & Development Co.	2,789,891
Cutting knife lube	oleic soap	triethanolamine	Republic Steel Corp.	2,790,771

Continued on p. 218

THE WORLD'S MOST MODERN REFINERIES USE

Proof Again . . . GREENWOOD GATE VALVE LINE BLINDS

NO BOLTS TO LOOSEN • NO LIFTING OF PLATES • NO SPREADING OF LINE

• Like so many modern refineries, the new 130,000 b/d Tidewater Oil Company plant at Delaware City, Delaware is using GREENWOOD GATE VALVE LINE BLINDS for the ultimate in line blind efficiency, economy and ease of operation. **No other line blind is so simple and easy to change.** Just turn the hand wheel and the blind plate raises from the valve body into line with a machined carrier track incorporated in the top of the valve yoke. Here the blind plate or spectacle plate is then slid onto the valve stem and lowered into position. "O" ring seal and metal-to-metal seats between the wedge and valve body make the GREENWOOD Line Blind positive as a shut off blind.

THREE TYPES AVAILABLE

• *STRAIGHT* • *TEE* • *ELL*

SIZES: 2—20 inches

WORKING PRESSURE: 150 lbs., 300 lbs., 600 lbs.

Photo shows some of the many GREENWOOD GATE VALVE LINE BLINDS at the new Tidewater Oil Company refinery at Delaware City, Delaware. • They are located in the gasoline blending area.

GREENWOOD VALVE DIVSION

VERNON TOOL CO., LTD.

1101 MERIDIAN AVENUE • ALHAMBRA, CALIFORNIA

(To obtain more data on advertised products see page 230)

why wonder?

You can be sure you're getting a ready-to-go steam trap when you buy a Nicholson . . . because each and every one is tested in actual steam service before shipment.

And that's not all. With just one thermostatically-operated moving part, there's nothing to get out of order, nothing to go wrong. Nicholson means continuous operation of your steam-using equipment . . . no downtime from trap failure.

- **high air-venting capacity . . . for faster warmup of equipment.**
- **powerful valve action . . . no mechanical linkages to cause trouble.**
- **small and lightweight . . . easy to pipe and support.**

So, to get a trap that's service-tested, and loaded with operating features, specify Nicholson. W. H. NICHOLSON AND COMPANY, 14 OREGON ST., WILKES-BARRE, PA., *Sales and Engineering offices in 98 principal cities.*

Write for Bulletin 1055

NICHOLSON

of Wilkes-Barre

(To obtain more data on advertised products see page 230)

Patents (continued)

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT NO.
Cutting oil	mineral oil	organic polysulfides	Standard Oil Co. (Ohio)	2,790,772-5
Filtration	hydrocarbon oils	agitated filter system	Esso Research & Engrg. Co.	2,789,696
Grease	oleaginous base	metal soap thickener	Standard Oil Co. (Ind.)	2,790,770
	oleaginous lube base	metal salt & indigo	The Texas Company	2,791,560
	oleaginous lube	gelling agent	Socony Mobil Oil Co., Inc.	2,790,767
High temp. grease	mineral lube oil	saponifiable additives	Esso Research & Engrg. Co.	2,790,769
Lubricant	dicarboxylic acid diester	TCP, phenothiazine & dilauryl selenide	Standard Oil Co. (Ind.)	2,792,346
Lubricant	mineral lube oil	alkyl phenol additive	Gulf Oil Corp.	2,789,950
	mineral lube oil	mixed metal complex salt of phosphoric acid esters	Socony Mobil Oil Co., Inc.	2,790,765-6
	mineral lube oil	sulfonate, dithiophosphate & polymer	The Texas Company	2,790,768
	paraffin-base lube oil	combination additive	Esso Research & Engrg. Co.	2,791,559

Equipment

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT NO.
Calibration	flowmeters	closed measuring cylinder	Shell Development Co.	2,792,705
Coking	acid sludge	improved wear ring on rotating coker	Standard Oil Co. (Ind.)	2,792,339
Combustion	fuels	regenerative furnace	Phillips Petroleum Co.	2,792,437
Contacting	partially miscible liqs.	multi-stage contactor	Esso Research & Engrg. Co.	2,791,536-8
Dehydrating & filtering	gas	cooling in helical passages	Hankison Corp.	2,790,507
Dilution	chemicals	plurality of tank compartments	Standard Oil Co. (Ohio)	2,791,494
Feeding	fluid reactants	feed manifold	Socony Mobil Oil Co., Inc.	2,789,889
Filtering	slurries	continuous rotary filter	Texaco Development Corp.	2,791,334
Fractionation	liquids	unitary glass bubble plate & downcomer	California Research Corp.	2,789,803
Homogenizing	lubricants	supersonic compression waves in mixer	J. L. Hall	2,791,403
Indication	liquid level	mercury filled U-shaped conduit	U. S. of America—AEC	2,791,119
Pressure relief	inflammable gases	blowdown drum & vent stack	Phillips Petroleum Co.	2,792,070
Purification	crystals	melting & filtering	Phillips Petroleum Co.	2,791,333
Separation	fluids	thermal diffusion apparatus	Standard Oil Co. (Ohio)	2,789,945-6
Synthesis	organic compounds	Fischer-Tropsch reaction	U. S. of America—Interior Dept.	2,789,888

REPAIR LEAKS
QUICKLY—PERMANENTLY

SKINNER-SEAL PIPE JOINT CLAMPS stop leaks at joints. Put on under pressure—without interruption of service. Quick, simple, lasting repair. Sizes 1/2" to 24" incl. in stock.

SKINNER-SEAL COLLAR LEAK CLAMP—designed to stop every type of collar leak in oil and gas lines. Sizes: 2" to 13" inclusive.

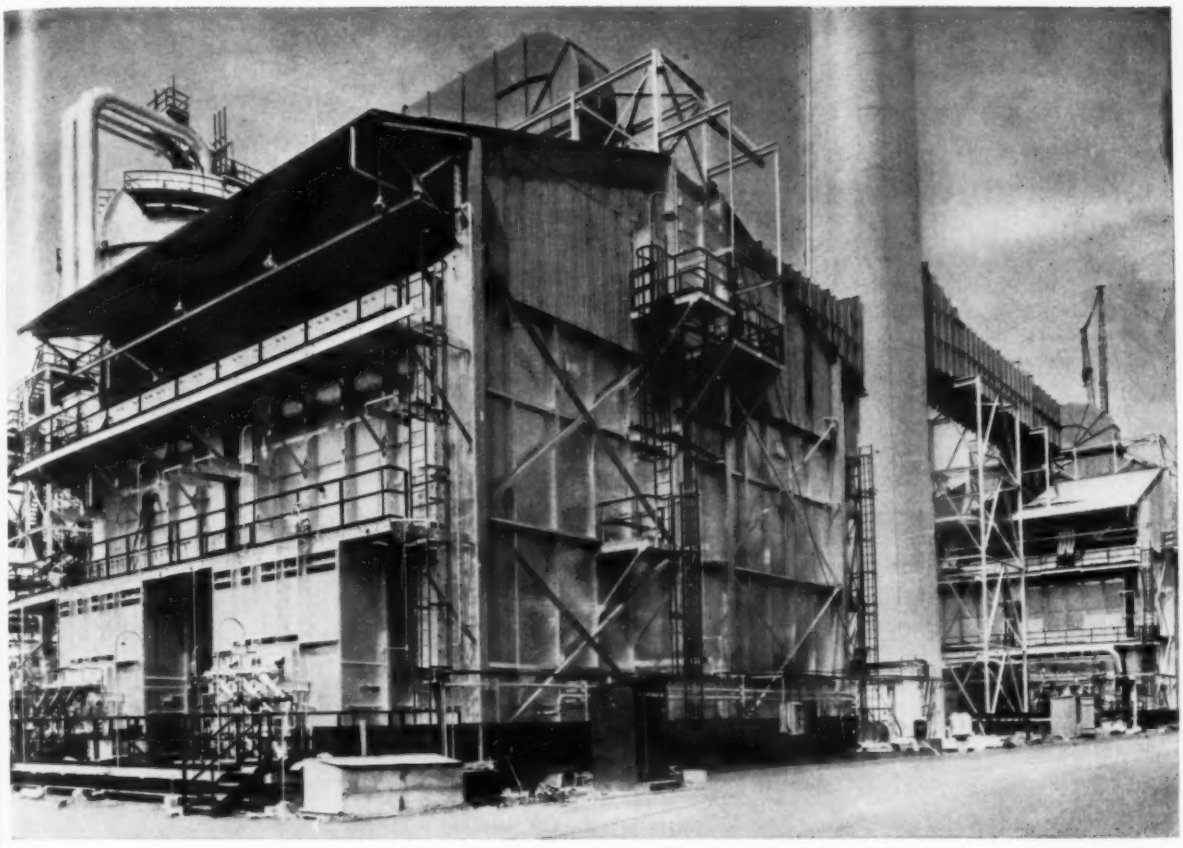
M. B. SKINNER COMPANY
SOUTH BEND 21, INDIANA, U. S. A.

CUT INVENTORY 50% WITH

ANNIN DEVELOPED AND INTRODUCED: SPLIT BODY DOMOTOR OPERATOR · TEFLON SEAT SEAL · DOOLSEAL

ANNIN Control VALVES

THE ANNIN COMPANY
6570 East Telegraph Road
Los Angeles 22, California



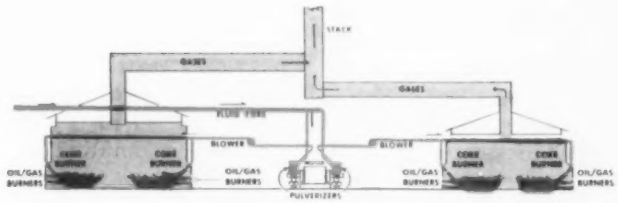
357,000,000 btu/hr

from two FW direct-fired oil heaters designed to burn FLUID COKE

SUPPLYING the heat requirements of the world's highest capacity crude distillation unit at the new ultra-modern Delaware Flying A Refinery of Tidewater Oil Company, the two Foster Wheeler direct-fired oil heaters shown above have a heat absorption capacity of 357 million btu per hr. The petroleum industry's first direct-fired heaters designed to burn fluid coke, they are capable of heating 130,000 bbl of crude per day.

Fluid coke can be burned at the rate of approximately 220 tons per day, supplying one half of the total direct heat requirements when operating at full capacity. Fuel oil or gas burning will supply the other half.

This installation is another example of Foster Wheeler's ability to design and construct direct-fired heaters of exceptionally high heat-duty requirements. This specialized



experience can help you save time and expense in meeting your exact requirements for special heating and vaporization units. For full details on the 357,000,000 btu/hr units above, send for the Nov.-Dec. Heat Engineering. *Foster Wheeler Corporation, 165 Broadway, New York 6, N.Y.*

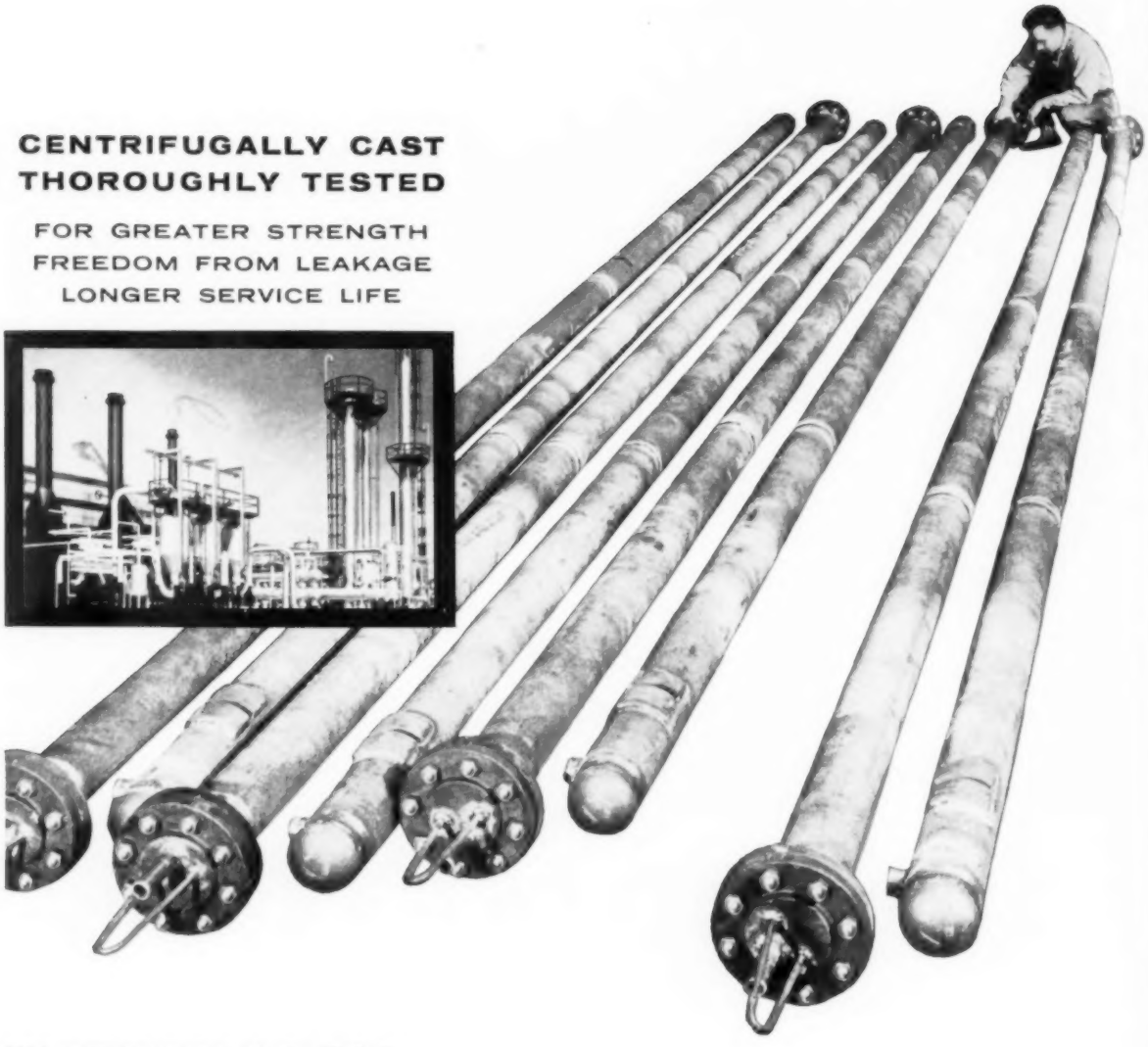
FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

(To obtain more data on advertised products see page 230)

CENTRIFUGALLY CAST
THOROUGHLY TESTED

FOR GREATER STRENGTH
FREEDOM FROM LEAKAGE
LONGER SERVICE LIFE



THERMALLOY

REFORMER FURNACE TUBES

The Thermalloy* Reformer Furnace Tubes you see above are designed to operate at 1820° F.—with internal pressure of 150 psig. To insure freedom from leakage and long service life, the individual cast tube sections underwent a hydrostatic test of 3000 psi. In addition, each assembly was tested at 900 psi.

Tube sections are centrifugally cast to specified diameters—to insure greater density, finer grain structure and uniform thickness. And experienced Electro-Alloys metallurgists and engineers can help you select the grade of high-heat-resistant Thermalloy best suited to your particular application.

Recent expansion of Electro-Alloys' centrifugal casting facilities means we can meet your needs for Reformer Tube Assemblies promptly. Call your nearby Electro-Alloys representative. Or write for Bulletin T-283. Electro-Alloys Division, 8077 Taylor Street, Elyria, Ohio.

*Reg. U. S. Pat. Off.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION Elyria, Ohio

All about plant maintenance

Maintenance Engineering Handbook, edited by L. C. Morrow, 1457 pp, plus index, $20, McGraw-Hill Book Co., 330 W. 42nd St., N. Y. 36.

MORE than 80 specialists have contributed the 96 chapters. Editor is L. C. Morrow, one of the country's most prominent maintenance specialists.

Here is a handbook for reading as well as reference. The first five sections (23 chapters) will give both maintenance and management executives the true picture of the maintenance function and its relationship to plant operation. The material is original; it assembles information on the management of maintenance otherwise unavailable under a single cover. Some sections and authors included are:

Principles of Organization and Operating Practices Maintenance Can Follow (Henry W. Shockley)

Operating Policies by Which Management Should Be Guided (Charles E. Knight)

Pros and Cons of Preventive Maintenance (Carl G. Wyder)

Training Operators and Supervisors (Ralph G. Smith), Dealing with Maintenance Labor (Edmund Balzano), Rating and Evaluating Maintenance Jobs (George E. Meyers), and Incentive Pay for Maintenance Workers (W. C. Cooling) constitute the section on "Maintenance Personnel Administration."

Costs and Budgets for Maintenance Operations is the title of another four-chapter section.

Maintenance of equipment, of course, makes up the greater part of the handbook—there are something like 80 chapters. These chapters should be studied by the people particularly responsible for continuous operation of equipment or services.

Book briefs

Inventors and Inventions, C. D. Tuska, 135 pp, illustrated, $3.75, McGraw-Hill Publishing Co., 330 W. 42nd St., N. Y. 36, N. Y.

. . . a manual, with case histories, to encourage and instruct in the psychology and methods of invention. Suggestions for the improvement of creative ability, and also information on patenting and marketing are included.

Your Opportunities in Industry as a Technician, 6x8½ in., 30 pp, pamphlet, National Assn. of Manufacturers, 2 E. 48th St., N. Y. 17, N. Y.

. . . management trying to encourage high school students to go into technician training might look into this booklet as a way of reaching its audience. Written in an easy style, and attractively illustrated, the booklet tries to help readers understand what kinds of jobs exist for technicians, what the intellectual and personality requirements are for these positions, and what academic training will best prepare the person for a career as technician. Technician here means subprofessional technical worker.

Continued Education and **Reading List for Engineers,** each 15 pp, paper bound, and 10¢, Industry Training Committee of Detroit's Engineers Council for Professional Development, 100 Farnsworth Ave., Detroit 2, Mich.

. . . two handy little references for the engineer who wants to take some more schooling (though only in the Detroit area) or dip into a bit of background reading. The reading list contains titles in philosophy, economics and sociology, natural science, business and industrial management, poetry and fiction, history and politics—all wholly respectable books. These were chosen as appropriate for the first five years of an engineer's professional development.

Biological Treatment of Sewage and Industrial Wastes, Vol. I—Aerobic Oxidation, edited by J. McCabe and W. W. Eckenfelder, Jr., 6x9 in., 392 pp, $10, Reinhold Publishing Corp., 430 Park Ave., N. Y. 22, N. Y.

. . . this record of the proceedings of the first Conference on Biological Waste Treatment, held at Manhattan College, covers four areas: principles of bio-oxidation, principles of oxygen transfer and their application to aeration equipment, and design and operation of sewage and industrial waste treatment processes.

Minerals Yearbook, Vol. III, Area Reports, 1953, 6x9 in., 1169 pp, $4.00, U. S. Bureau of Mines, available through Govt. Printing Office, Washington 25, D. C.

. . . gives reports by states and counties on production of both petroleum and other mineral commodities for 1953. Also includes state-by-state summaries by volume and dollar value.

Creative Communication, by Edwin Laird Cady, 1956, 5x7 in., 158 pp, hard cover, $2.50, Reinhold Publishing Corp., 430 Park Ave., N. Y. 22, N. Y.

. . . an excellent and, despite its slimness, thorough discussion of why communication breaks down between people, especially technical people, and how they can establish good communication. By "creative" the author means what many people call "effective" communication. That is, it "creates" understanding or the willingness to do what is suggested. Author is described as a management consultant, but don't let that put you off—he seems to know about the work of engineers. He's highly practical too. There are chapters titled "Hints on How to Work" and "Hints About Writing," and the other pages are also filled with "how to" information. Most impressive in the book are the careful analysis of the communication "situation" and the clarity and conciseness of the writing itself.

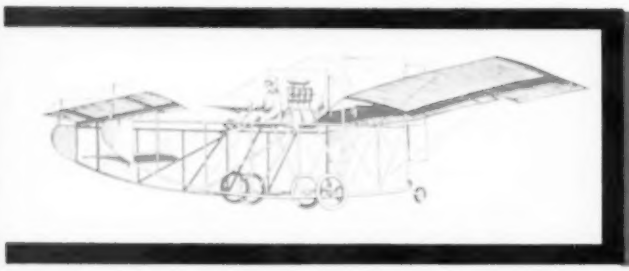
RP-500, Recommended Practice for Classification of Areas for Electrical Installations in Petroleum Refineries, second edition, 1957, $0.75, American Petroleum Institute, 50 W. 50th St., N. Y. 20, N. Y.

. . . includes a specific procedure for evaluating the existence, degree, and extent of a hazardous refinery area under the provisions of the National Electrical Code. Also contains a discussion of the principles involved.

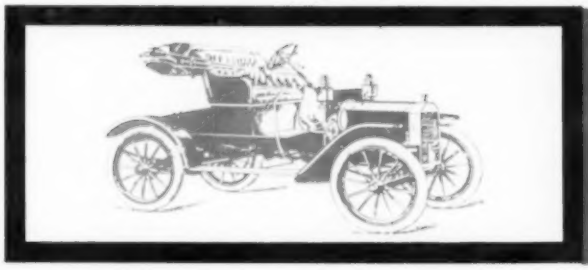
Pump Selection and Application, by Tyler G. Hicks, 1957, 6x9 in., 422 pp, hard cover, $8.50, McGraw-Hill Book Co., 330 W. 42nd St., N. Y. 36, N. Y.

. . . a book designed to save you time in choosing the right pump in any application. Divided into three parts, it devotes the first section to a description of all types of pumps, the second to the major design factors in selecting the proper pump. The last section describes many types of pumps operating satisfactorily in 14 different industries, including petroleum and chemicals.

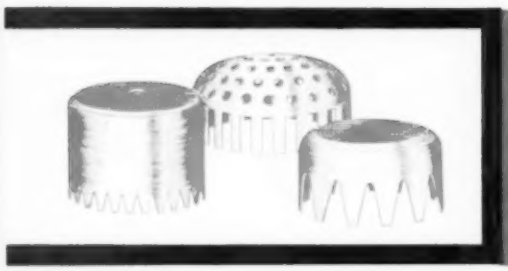
there's been

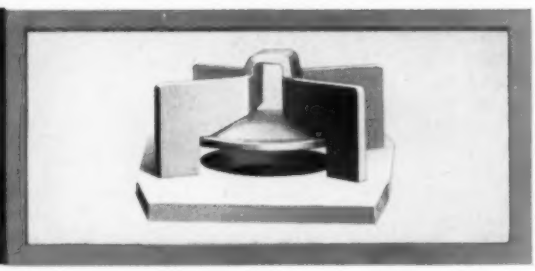


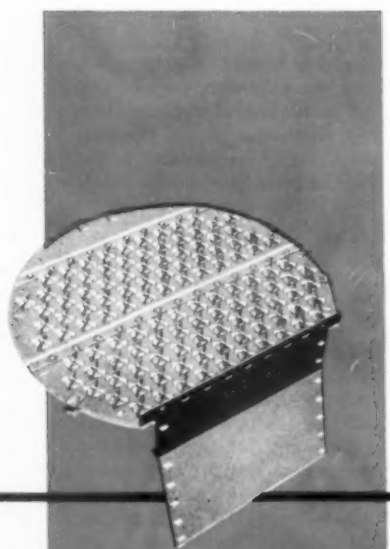
some changes made



in fractionating trays, too!







REPRESENTATIVES

Today's trend in progress is away from "horse-and-buggy" bubble trays to Koch's jet-age **FLEXITRAY** . . . and, for good reason!

With "Flexitray," the entire tray area is available for vapor-liquid breakout . . . no obstruction to liquid flow exists . . . vapor separates at lower velocities. "Flexitrays" remain cleaner – longer!

With its extreme flexibility and capacities, it is small wonder that major companies – looking for the best designed trays – have adopted "Flexitray" for more than 400 **NON-CAPTIVE** installations.

Write . . . wire . . . phone your nearest Koch representative or:

KOCH ENGINEERING COMPANY, INC.

DESIGNERS AND FABRICATORS OF MODERN TRAYS

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Pittsburgh, Pennsylvania Representative: D. D. Foster Company, 501 Alcoa Building
West Coast Representative: Jacobs Engineering Company, Pasadena: RYan 1-9373; Oakland, TEmplebar 2-5391
Illinois Representative: M. B. Fisher, 1521 Courtland Avenue, Park Ridge, Illinois

ISA meeting keyed to systems control

THIS year's instrument-automation conference of the Instrument Society of America will be organized around the theme, "Instrumentation for Systems Control." The event will be held in the Cleveland Auditorium from Sept. 9 to 13.

Workshop sessions on instrumentation will include the following topics: process industries, power generation and distribution, and nuclear systems.

Discussion of "horizontal" topics will follow, including oscillographic and photographic data reduction, data transmission and storage, analog-to-digital (and vice-versa) converters, real time digital and analog computer applications, transducers, etc.

A new conference feature, the "systems workshop," which will examine the new "systems" concept, will be led by Chalmer E. Jones, Daystrom, Inc. William Vannah, Control Engineering, will keynote this session with a definition of the concept.

A computers application clinic will be chaired by Irving Lefkowitz, Case Institute of Technology. Lecture demonstrations featuring actual operation and solution of problems with computers will also be a part of this clinic.

Other keynote speakers will be Dr. Simon Ramo, executive vice-president, Ramo-Wooldridge, Inc., and Dr. Cuthbert Hurd, director of central research for IBM.

The "New Ideas in Instrumentation" contest will be held again.

Tour plans for AIEE Petroleum Conference

Plant tours in the Philadelphia area will be part of the refining activities at the American Institute of Electrical Engineers' Electrical Conference of the Petroleum Industry. Site of the meeting will be the new Sheraton Hotel in Philadelphia, from September 9 to 11.

Most of the tours for refiners will take place on Sept. 10, and the following are the places scheduled to be visited.

The cat cracker of Atlantic Refining Co.'s Philadelphia refinery,

The ammonia plant of Sun Oil Co. at its Marcus Hook plant,

The power installation of Delaware Power & Light Co., located at Tidewater Oil Co.'s new Delaware City refinery,

Tidewater's new refinery.

The transportation group plans to visit the quarry oil storage facilities of Esso Standard Oil Co. at Wind Gap, Pa.

Further details of the Electrical Conference will appear in a future issue of PETROLEUM PROCESSING.

Oil Man's Calendar

Boldface items reviewed in this issue

JULY

15-19 Gordon Conference on Corrosion, Colby Junior College, New London

22-26 Electronic Data Processing for Business and Industry, Hotel Roosevelt, New York City

AUGUST

11-15 Heat Transfer Conference, American Society of Mechanical Engineers, Pennsylvania State College, University Park, Pa.

12-14 Society of Automotive Engineers, West Coast, Olympic Hotel, Seattle

26-28 Appalachian Gas Measurement Short Course, West Virginia University, Morgantown, W. Va.

26-30 American Institute of Electrical Engineers, Pacific General, Yakima, Wash.

28-30 Institute Society of America, first symposium on gas chromatography, East Lansing, Mich.

SEPTEMBER

8-13 American Chemical Society, national meeting, New York City

9-11 Electrical Conference of the Petroleum Industry, American Institute of Electrical Engineers, Sheraton Hotel, Philadelphia

9-13 Instrument Automation Conference and Exhibit, Instrument Society of America, Cleveland Auditorium, Cleveland.

11-13 National Petroleum Assn., annual, Traymore Hotel, Atlantic City

15-18 American Institute of Chemical Engineers, national meeting, Lord Baltimore Hotel, Baltimore, Md.

23-25 Petroleum Mechanical Conference, ASME, Tulsa, Okla.

23-25 American Society of Mechanical Engineers, fall meeting, Statler Hotel, Hartford, Conn.

26-27 Western Petroleum Refiners Assn., Rocky Mountain regional technical-industrial relations meeting, Henning Hotel, Casper, Wyo.

27 Natural Gasoline Assn. of America, Oklahoma Regional, Skirvin Hotel, Oklahoma City

OCTOBER

1-4 National Assn. of Corrosion Engineers, North Central Region meeting, Sherman Hotel, Chicago

1-4 National Assn. of Corrosion Engineers, South Central Region, Oklahoma City, Oklahoma

6-10 American Society for Testing Materials, Committee D-2, Sheraton-Park Hotel, Washington, D.C.

7-9 Lubrication Conference, ASME and the American Society of Lubrication Engineers, Royal York Hotel, Toronto

7-9 American Gas Assn., annual, Kiel Auditorium, St. Louis, Mo.

7-11 American Institute of Electrical Engineers, fall general meeting, Morrison Hotel, Chicago

9-11 Symposium on High Vacuum Technology, Committee on Vacuum Techniques, Hotel Somerset, Boston, Mass.

10-11 California Natural Gasoline Assn., annual, Huntington-Sheraton Hotel, Pasadena, Calif.

21-23 American Society of Mechanical Engineers, power meeting, Americus, Hotel, Allentown, Pa.

22 American Institute of Chemical Engineers, New York Section, Hotel Statler, New York

22-24 Western Regional Conference, National Assn. of Corrosion Engineers, San Diego, Calif.

23-25 Permian Basin Corrosion Tour, NACE, Odessa, Texas

24-25 Western Petroleum Refiners Assn., regional technical-industrial relations meeting, Garrett Hotel, El Dorado

25 Natural Gasoline Assn. of America, Southern Region meeting, Washington-Youree and Capt. Shreve Hotels, Shreveport, La.

28-29 National Lubricating Grease Institute, annual, Edgewater Beach Hotel, Chicago

NOVEMBER

4-8 National Metal Congress & Exposition and 2nd World Metallurgical Congress, sponsored by the American Society for Metals and others, International Amphitheater, Chicago, Ill.

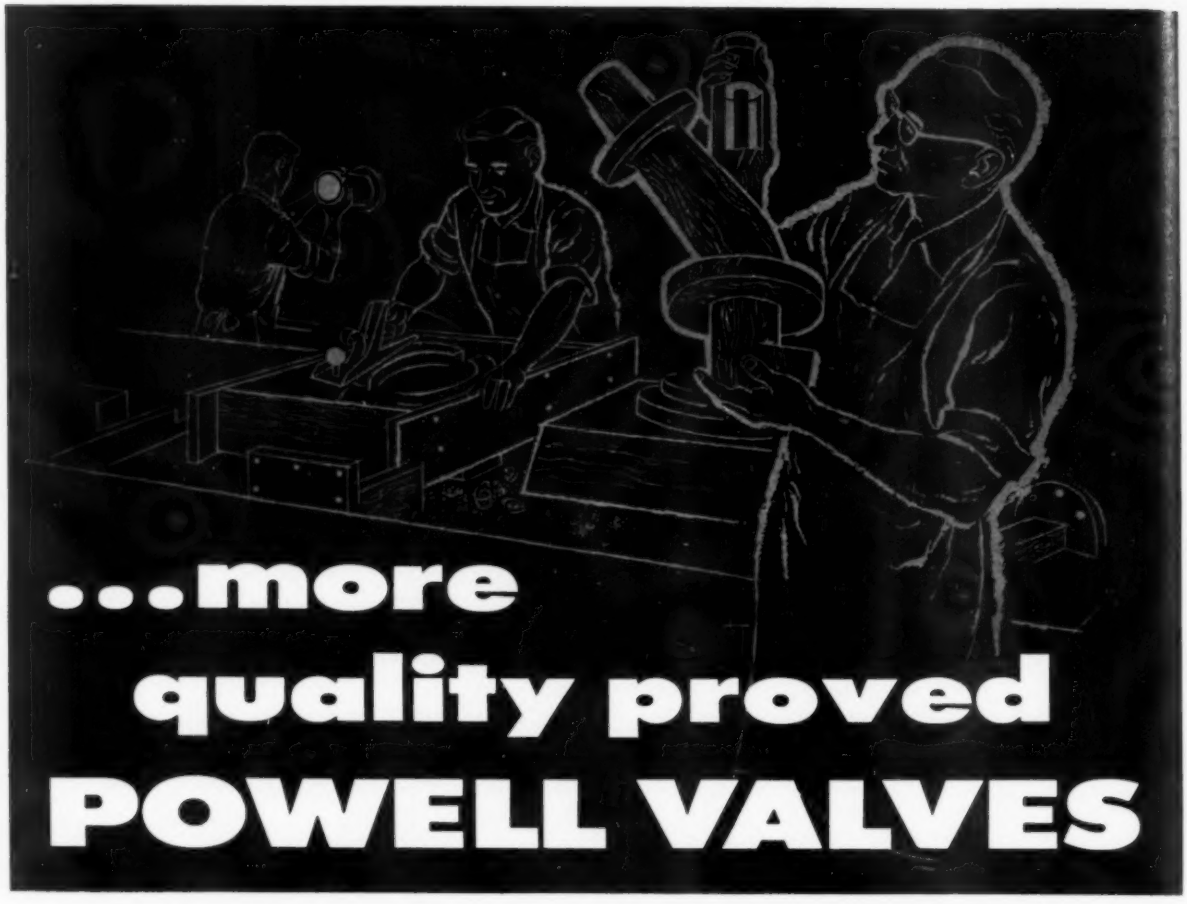
6-8 Society of Automotive Engineers, fuels and lubes meeting, Hotel Statler, Cleveland

11-14 American Petroleum Institute, annual, Conrad Hilton Hotel, Chicago

DECEMBER

1-6 American Society of Mechanical Engineers, annual, Statler, New York

8-11 American Institute of Chemical Engineers, annual, Hilton Hotel, Chicago



...more quality proved POWELL VALVES

Fig. 2201—175-Pound W.O.G. Semi-Steel Lubricated Plug Valve.

Fig. 86196—Steel "LPG" Horizontal Lift Check Valve for 400 W.O.G.

Fig. 375—Bronze Gate Valve for 200 Pounds W.S.P. Union Bonnet. Inside Screw Rising Stem.

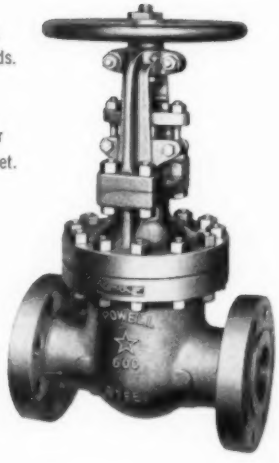
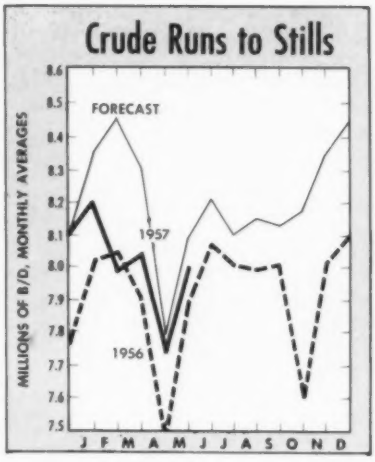


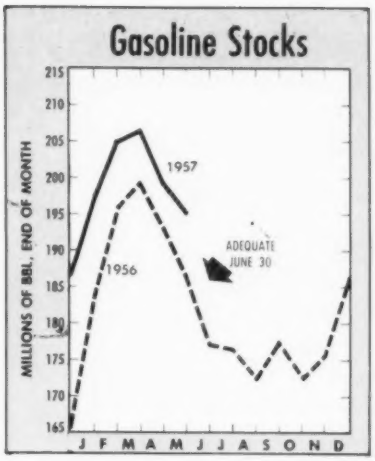
Fig. 6003—Steel O.S.&Y. Gate Valve for 600 Pounds.

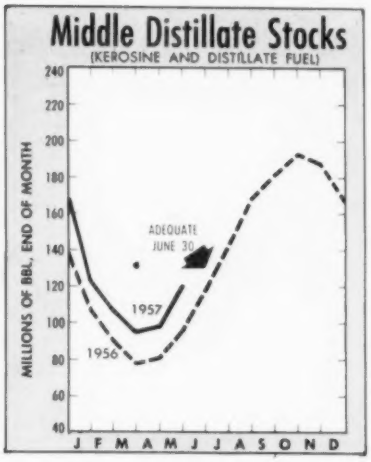
for quality-crafted flow control

Ask your Powell Valve Distributor for the facts about quality-proved bronze, iron, steel and corrosion-resistant valves. Whatever your flow control problem, there's a Powell Valve to solve it.

THE WM. POWELL COMPANY, CINCINNATI 22, OHIO . . . 111th YEAR






Middle Distillate Stocks
(KEROSINE AND DISTILLATE FUEL)
MILLIONS OF BBL, END OF MONTH
ADEQUATE JUNE 30
1957
1956
J F M A M J J A S O N D

Storm warning on distillate fuels

OUTLOOK: Reduction in crude runs and plant closures through strikes, if continued, will tighten gasoline supplies in some areas by early fall.

WITH nearly four months left of the seasonal buildup period for distillate fuel oil stocks, the present imbalance of supply and demand for this product is a source of concern to many refiners. The excess of supplies comes both from the increased volume of crude runs to refinery stills this year, and also from the higher yield of this product which refiners have achieved.

Stimulated by the emergency needs for supplies for Western Europe, average yields of distillate fuels for the U. S. reached 25% in January and February, the highest on record. Through April and May they were running close to 23%. During 1956 the rate of output ranged from 21.4% in May to 24% in December.

On March 29 total U. S. distillate fuel oil stocks were 75,855,000 bbl, some 13,000,000 bbl more than on Mar. 30, 1956, despite the greatly increased exports this year. Domestic demand the first four months was 6.1% greater than in 1956. On June 7 these inventories were 101,789,000 bbl above those of June 8, 1956. The buildup of these stocks to June 7 has been nearly 26,000,000 bbl, compared with 18,000,000 in the same weeks of the buildup period a year ago.

In 1956 these inventories increased 70,200,000 bbl from June 8, to 150,800,000 bbl Sept. 30. A buildup this year of even the same volume in the same weeks, will bring the total Sept. 30 to nearly 172,000,000 bbl. The forecast of adequate inventories Sept. 30, based on estimated needs for the coming heating season, is 156,600,000 bbl. The warning seems obvious for refiners to put less emphasis, in the coming weeks, on distillate fuel oil production.

U. S. refiners' stocks of this product June 7 were 26.2% larger than on June 8, 1956 (see table). All districts except the Texas and Louisiana Gulf Coast areas have largely increased stocks compared with early summer a year ago. In the East Coast district, which supplies a concentrated heating oil market, stocks June 7 were 51.6% larger than a year ago. This is in part offset by the fact that stocks in the Gulf Coast districts, which supply part of the eastern heating market, are at the same level as last year.

MAY KEY STATISTICS

(Figures given in terms of millions of b/d, monthly averages, except stocks, which are in millions of bbl at end of month)

	May 1957	April 1957	May 1956
CRUDE OIL			
U. S. Production	7.462	7.527	7.064
Imports	1.003	.891	.938
U. S. Stocks	268.601	261.050	277.497
Runs to Stills	8.015	7.746	7.896
GASOLINE			
Refinery Output	3.835	3.741	3.756
Refinery Demand	4.079	4.002	4.093
Primary Stocks	195.285	199.142	186.673
MIDDLE DISTILLATES			
Refinery Output	2.113	2.047	1.959
Refinery Demand	1.365	1.993	1.465
Primary Stocks	121.901	97.995	97.811
RESIDUALS			
Refinery Output	1.134	1.165	1.149
Imports & Other	.425	.558	.454
Total Supply	1.559	1.723	1.603
Refinery Demand	1.468	1.723	1.478
Primary Stocks	40.067	37.240	36.607

PRODUCT AND CRUDE PRICES

(Products—¢ gal, weighted average prices in principal refinery markets
Crudes—$/bbl, principal fields
Source—Platt's Oilgram Price Service)

	May 1957	April 1957	May 1956
Gasoline (regular)	12.72	12.71	12.01
Distillate Fuel Oil	10.27	10.38	9.36
Kerosine	11.75	11.90	10.93
Residuals	6.42	6.42	5.19
Above 4 Products	10.41	10.43	9.51
Lube Oils	24.17	24.17	22.45
Crude	3.18	3.18	2.84

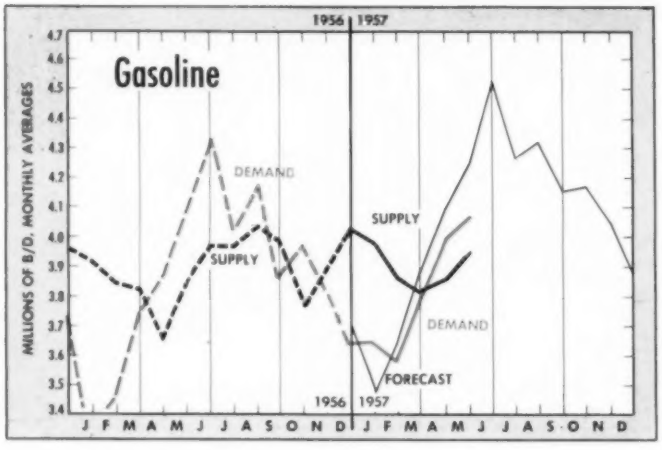
REFINERY YIELDS

% on Crude Runs to Stills

	May 1957	April 1957	May 1956
Gasoline	43.8	44.1	44.0
Kerosine	3.6	3.6	3.7
Distillate	22.8	22.8	21.4
Residuals	14.1	15.0	14.8

SOURCE OF DATA (except prices): April and May, API weekly reports; earlier months Bureau of Mines

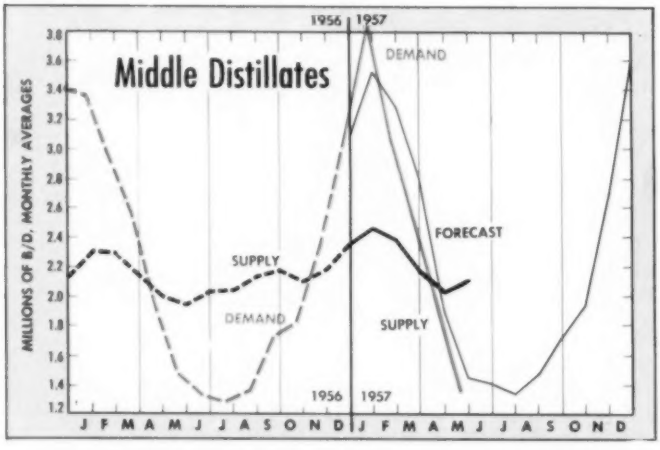
Gasoline lags in seasonal spring upturn


Gasoline
1956 | 1957
MILLIONS OF B/D. MONTHLY AVERAGES
DEMAND
SUPPLY
SUPPLY
DEMAND
FORECAST
1956 1957
J F M A M J J A S O N D J F M A M J J A S O N D

MOTOR FUEL

	From Crude		From Nat. Gas		Total
SUPPLY (Millions of b/d)					
May '57	3.508		.447		3.955
May '56	3.423		.436		3.859
Change	+ .085		+ .011		+ .096
% Change	+ 2.5		+ 2.5		+ 2.5
DEMAND (including Exports) (Millions of b/d)					
May '57					4.079
May '56					4.093
Change					— .014
% Change					— 0.3
TOTAL SUPPLY (Millions of bbl)					
5 Mos. '57	519.405		69.504		588.909
5 Mos. '56	515.613		65.578		581.191
Change	+ 3.792		+ 3.926		+ 7.718
% Change	+ 0.7		+ 6.0		+ 1.3
TOTAL DEMAND (including Exports) (Millions of bbl)					
5 Mos. '57					577.924
5 Mos. '56					561.702
Change					+ 16.222
% Change					+ 2.9

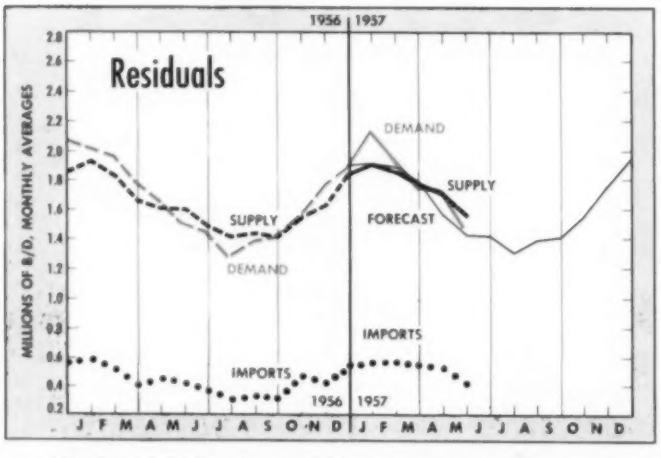
Wide gap between distillate fuel supply and demand


Middle Distillates
1956 | 1957
MILLIONS OF B/D. MONTHLY AVERAGES
DEMAND
FORECAST
SUPPLY
DEMAND
SUPPLY
1956 1957
J F M A M J J A S O N D J F M A M J J A S O N D

MIDDLE DISTILLATES

	Kerosine		Dist. Fuel Oil		Total
PRODUCTION (Millions of b/d)					
May '57	.285		1.828		2.113
May '56	.292		1.667		1.959
Change	— .007		+ .161		+ .154
% Change	— 2.4		+ 9.7		+ 7.9
DEMAND (including Exports) (Millions of b/d)					
May '57	.147		1.218		1.365
May '56	.179		1.286		1.465
Change	— .032		— .068		— .100
% Change	— 17.9		— 5.3		— 6.8
TOTAL PRODUCTION (Millions of bbl)					
5 Mos. '57	48.860		289.942		338.802
5 Mos. '56	51.731		274.336		326.067
Change	— 2.871		+ 15.606		+ 12.735
% Change	— 5.5		+ 5.7		+ 3.9
TOTAL DEMAND (including Exports) (Millions of bbl)					
5 Mos. '57	55.685		330.583		386.268
5 Mos. '56	57.524		312.913		370.437
Change	— 1.839		+ 17.670		+ 15.831
% Change	— 3.2		+ 5.6		+ 4.3

Actual residual demand close to forecast level



RESIDUAL FUELS

	Refinery Output		Imports & Other		Total
SUPPLY (Millions of b/d)					
May '57	1.134		.425		1.559
May '56	1.149		.454		1.603
Change	— .015		— .029		— .044
% Change	— 1.3		— 6.4		— 2.9
DEMAND (including Exports) (Millions of b/d)					
May '57					1.468
May '56					1.478
Change					— .010
% Change					— 0.7
TOTAL SUPPLY (Millions of bbl)					
5 Mos. '57	183.991		82.134		266.125
5 Mos. '56	186.084		77.623		263.707
Change	— 2.093		+ 4.511		+ 2.418
% Change	— 1.1		+ 5.8		+ 0.9
TOTAL DEMAND (including Exports) (Millions of bbl)					
5 Mos. '57					270.424
5 Mos. '56					266.274
Change					+ 4.150
% Change					+ 1.6

SOURCE OF DATA: April and May, API weekly reports; earlier months Bureau of Mines (1956 figures for 366 days)

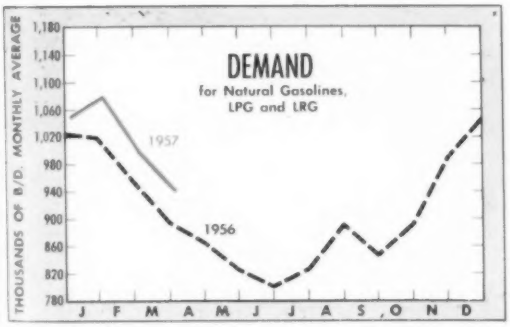
RUNS TO STILLS AND DISTRIBUTION OF PRIMARY STOCKS BY U. S. REFINERY DISTRICTS

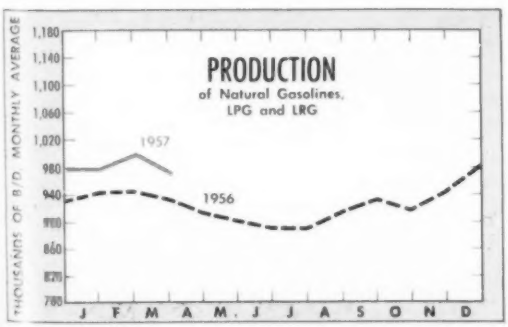
(Primary stocks include those at refineries, at large terminals and in pipelines; all data based on API reports)

District	RUNS TO STILLS (Millions of b/d average for week ending on date shown) June 7 1957	June 8 1956	Change	% Change	GASOLINE STOCKS (Millions of bbl on date shown) June 7 1957	June 8 1956	Change	% Change	RESIDUAL STOCKS (Millions of bbl on date shown) June 7 1957	June 8 1956	Change	% Change
East Coast	1.205	1.121	+ .084	+ 7.5	43.451	41.042	+ 2.409	+ 5.9	10.419	8.784	+ 1.635	+18.6
Gulf Coast	2.650	2.781	— .131	— 4.7	37.027	34.239	+ 2.788	+ 8.1	6.614	6.763	— .149	— 2.2
Total Coastal	3.855	3.902	— .047	— 1.2	80.478	75.281	+ 5.197	+ 6.9	17.033	15.547	+ 1.486	+ 9.6
Appalachian	.203	.202	+ .001	+ 0.5	7.476	7.446	+ .030	+ 0.4	.787	.608	+ .179	+29.5
Ind.-Ill.-Ky.	1.488	1.412	+ .076	+ 5.4	37.644	37.590	+ .054	+ 0.1	5.612	4.438	+ 1.174	+26.5
Okla.-Kans.-Mo.	.729	.776	— .047	— 6.1	20.940	20.365	+ .575	+ 2.8	1.070	1.318	— .248	—18.8
Other Inland	.672	.681	— .009	— 1.3	19.611	18.953	+ .658	+ 3.5	3.027	2.369	+ .658	+27.8
Total Inland	3.092	3.071	+ .021	+ 0.7	85.671	84.354	+ 1.317	+ 1.6	10.496	8.733	+ 1.763	+20.2
Total East of Calif.	6.947	6.973	— .026	— 0.4	166.149	159.635	+ 6.514	+ 4.1	27.529	24.280	+ 3.249	+13.4
Calif.	1.133	1.056	+ .077	+ 7.3	27.416	24.774	+ 2.642	+10.7	13.717	12.462	+ 1.255	+10.1
Total U. S.	8.080	8.029	+ .051	+ 0.6	193.565	184.409	+ 9.156	+ 5.0	41.246	36.742	+ 4.504	+12.3

District	DISTILLATE FUEL OIL STOCKS (Millions of bbl on date shown) June 7 1957	June 8 1956	Change	% Change	KEROSINE STOCKS (Millions of bbl on date shown) June 7 1957	June 8 1956	Change	% Change	TOTAL MIDDLE DISTILLATE STOCKS (Millions of bbl on date shown) June 7 1957	June 8 1956	Change	% Change
East Coast	33.398	22.026	+11.372	+51.6	10.624	8.739	+ 1.885	+21.6	44.022	30.765	+13.257	+43.1
Gulf Coast	18.021	18.026	— .005	—	6.052	5.990	+ .062	+ 1.0	24.073	24.016	+ .057	+ 0.2
Total Coastal	51.419	40.052	+11.367	+28.4	16.676	14.729	+ 1.947	+13.2	68.095	54.781	+13.314	+24.3
Appalachian	2.925	2.052	+ .873	+42.5	1.028	.943	+ .085	+ 9.0	3.953	2.995	+ .958	+32.0
Ind.-Ill.-Ky.	18.292	13.037	+ 5.255	+40.3	5.189	4.248	+ .941	+22.1	23.481	17.285	+ 6.196	+35.8
Okla.-Kans.-Mo.	11.193	9.858	+ 1.335	+13.5	1.717	1.422	+ .295	+20.7	12.910	11.280	+ 1.630	+14.5
Other Inland	6.617	5.717	+ .900	+15.7	1.312	1.158	+ .154	+13.3	7.929	6.875	+ 1.054	+15.3
Total Inland	39.027	30.664	+ 8.363	+27.3	9.246	7.771	+ 1.475	+19.0	48.273	38.435	+ 9.838	+25.6
Total East of Calif.	90.446	70.716	+19.730	+27.9	25.922	22.500	+ 3.422	+15.2	116.368	93.216	+23.152	+24.8
Calif.	11.343	9.921	+ 1.422	+14.3	.341	.403	— .062	—15.4	11.684	10.324	+ 1.360	+13.2
Total U. S.	101.789	80.637	+21.152	+26.2	26.263	22.903	+ 3.360	+14.7	128.052	103.540	+24.512	+23.7

Natural gas and refinery gas liquids





SUPPLY AND DEMAND STATISTICS
(Bureau of Mines Data)

	Mar. 1957	Feb. 1957	Mar. 1956
CURRENT PRODUCTION (1000 b/d monthly average)			
At Natural Gasoline and Cycling Plants			
Liquefied Petroleum Gas	439	463	426
Natural Gasoline and Isopentane	299	293	285
Condensate	20	20	22
Finished Gasoline, Naphtha and other	69	70	67
Total Natural Gasoline and Cycling Plant Production	824	846	800
Liquefied Refinery Gases	147	154	137
Total Marketable Gas Liquids	971	1,000	937
Lease Condensate	146	148	129
Total Natural Gas Liquids	1,117	1,148	1,066
CURRENT DEMAND (1000 b/d monthly average)			
LPG and LRG	539	615	531
Natural Gasoline, Isopentane and Other	397	379	365
Total Marketable Gas Liquids	936	994	896

	Mar. 1957	Mar. 1956
CUMULATIVE PRODUCTION (1000 bbl)		
LPG and LRG	54,355	52,127
Natural Gasoline, Isopentane and Other	34,155	33,814
Total Marketable Gas Liquids	88,510	85,941
CUMULATIVE DEMAND (1000 bbl)		
LPG and LRG	56,277	54,114
Natural Gasoline, Isopentane and Other	33,965	33,089
Total Marketable Gas Liquids	90,242	87,203

	Mar. 1957	Feb. 1957	Mar. 1956
STOCKS (1000 bbl, end of month)			
LPG and LRG	13,023	11,462	5,751
Natural Gasoline, Isopentane and Other	5,160	5,425	5,209
Total Stocks	18,183	16,887	10,960

INFORMATION OFFERED

Do you need detailed information on a specific subject? Check through this easy-to-use index of literature and data being offered in this issue's advertisements.

Adsorbents, fuller's earth, information; Floridin Co. See adv't. p. 256.

Aluminum chloride, literature; Solvay Process Div., Allied Chemical & Dye Corp. See adv't. p. 247.

Aluminum coatings, for process equipment, brochure; Arthur Tickle Engineering Works, Inc. See adv't. p. 244.

Catalysts, various types and shapes, booklet; Harshaw Chemical Co. See adv't. p. 1.

Chromatograph, gas, bulletin CEC 1836-X10; Consolidated Electrodynamics Corp. See adv't. p. 94.

Cleaning compounds, chemical, for process equipment, booklet; Oakite Products, Inc. See adv't. p. 254.

Compressors, centrifugal, bulletin 0504; De Laval Steam Turbine Co. See adv't. pp. 71-73.

Conveyor systems, air activated, bulletin; Robinson Conveyor Systems. See adv't. p. 60.

Cooling equipment, after coolers for gas or air, bulletin 130; Niagara Blower Co. See adv't. p. 258.

Cyclones, for catalyst recovery, dust control, bulletin CV-2506; Ducon Co., Inc. See adv't. p. 237.

Ducts and breeching, brochure; Connery Construction Co. See adv't. p. 208.

Engineering, design and construction, booklet; Refinery Engineering Co. See adv't. p. 39.

Engineering and construction, inforation; C. F. Braun & Co. See adv't. pp. 171-174.

Expansion joints and bellows, catalog; Solar Aircraft Co. See adv't. p. 257.

Fabrication and welding, process vessels, bulletin 7001; Eddystone Div., B-I.-H Corp. See adv't. p. 50.

Fabrication, pressure vessels, and heavy equipment, booklet; Newport News Shipbuilding and Dry Dock Co. See adv't. p. 185.

Fabrication, equipment and tanks, bulletin; Chicago Bridge & Iron Co. See adv't. p. 8.

Fittings, tube, catalog; Crawford Fitting Co. See adv't. p. 240.

Flow indicators, visible, bulletin F-6; Jordan Corp. See adv't. p. 192.

Gages, and instrument valves, liquid level, catalog sheets; Jerguson Gage & Valve Co. See adv't. p. 207.

Gas transport and storage equipment, information; Taylor-Wharton Co. See adv't. p. 215.

Gaskets, new catalog; Metallo Gasket Co. See adv't. p. 236.

Heaters, bulletin; Selas Corp. of America. See adv't. p. 86.

Heaters, oil, direct fired, booklet; Foster Wheeler Corp. See adv't. p. 219.

Instruments, control panel, small case, bulletin 13-18; Foxboro Co. See adv't. pp. 68-69.

Insulation, block, installation report; Baldwin-Hill Co. See adv't. pp. 44-45.

Insulation protection, fibrated asphalt base material, brochure; American Bitumuls & Asphalt Co. See adv't. p. 246.

Mist eliminators, wire mesh types, bulletin ME-6; Metal Textile Corp. See adv't. p. 251.

Mixers, side and top entering, mixer seals, 8 catalogs and data sheets; Mixing Equipment Co., Inc. See adv't. p. 98.

Motor starters, high voltage, for hazardous locations, bulletin 8131AM; Electric Controller & Mfg. Co. See adv't. p. 70.

Packings, plastic and metallic, catalog; Allpax Co., Inc. See adv't. p. 189.

Pipe, plastic lined, corrosion resistant, information; Dow Chemical Co. See adv't. p. 259.

Process equipment, towers, centrifuges, of alloys and glassed steel, specific bulletins; Pfaudler Co. See adv't. pp. 30-31.

Public Relations, booklet on Oil Progress Week; American Petroleum Institute. See adv't. p. 197.

Pumps, engineering report and diagrams; Byron-Jackson Pumps, Inc. See adv't. p. 79.

Pumps, centrifugal, circulars 190 & 191; Dean Brothers Pumps, Inc. See adv't. p. 260.

Pumps, vertical, for wet pit service, bulletin 110; Bingham Pump Co. See adv't. p. 42.

Pumps, for petroleum processes, specific bulletins available; Peerless Pump Div. See adv't. p. 249.

Recorders and analyzers, gas and va- por, literature; Mine Safety Appli- ances Co. See adv't. pp. 48-49.

Refrigeration units, literature; Frick Co. See adv't. p. 247.

Research report on high compression automobile engines; Ethyl Corp. See adv't. pp. 4-5.

Rotomotors, for valve actuation, bulletin 107-2; Conoflow Corp. See adv't. p. 175.

Scaffolding, tubular steel, reusable, bulletins PTS-18 & PTS-19; Patent Scaffolding Co., Inc. See adv't. p. 212.

Steam traps, bulletin 1055; W. H. Nicholson & Co. See adv't. p. 217.

Steam traps, impulse type, booklet and catalog; Yarnall-Waring Co. See adv't. pp. 76-77.

Steels, alloy clad, for corrosive service, bulletin; Lukens Steel Co. See adv't. pp. 40-41.

Stream blending, automatic, continuous, data; Proportioneers, Inc. See adv't. cover 2.

Sulfurs, brochure; Stauffer Chemical Co. See adv't. p. 82.

Tower packing, saddle shaped, bulletin IS-29; U. S. Stoneware Co. See adv't. p. 87.

Tube expanders and cutters, catalog 81; Gustav Wiedeke Co. See adv't. p. 250.

Tube maintenance tools, cleaners, expanders, bulletin 60; Airetool Mfg. Co. See adv't. p. 239.

Tubes, reformer furnace, cast, bulletin T-283; Electro-Alloys Div., American Brake Shoe Co. See Adv't. p. 220.

Tubes, finned, for heat exchangers, corrosion charts and catalog; Wolverine Tube. See adv't. pp. 55-56.

Valves, non-lubricated, bulletin CP6; Okadee Co. See adv't p. 238.

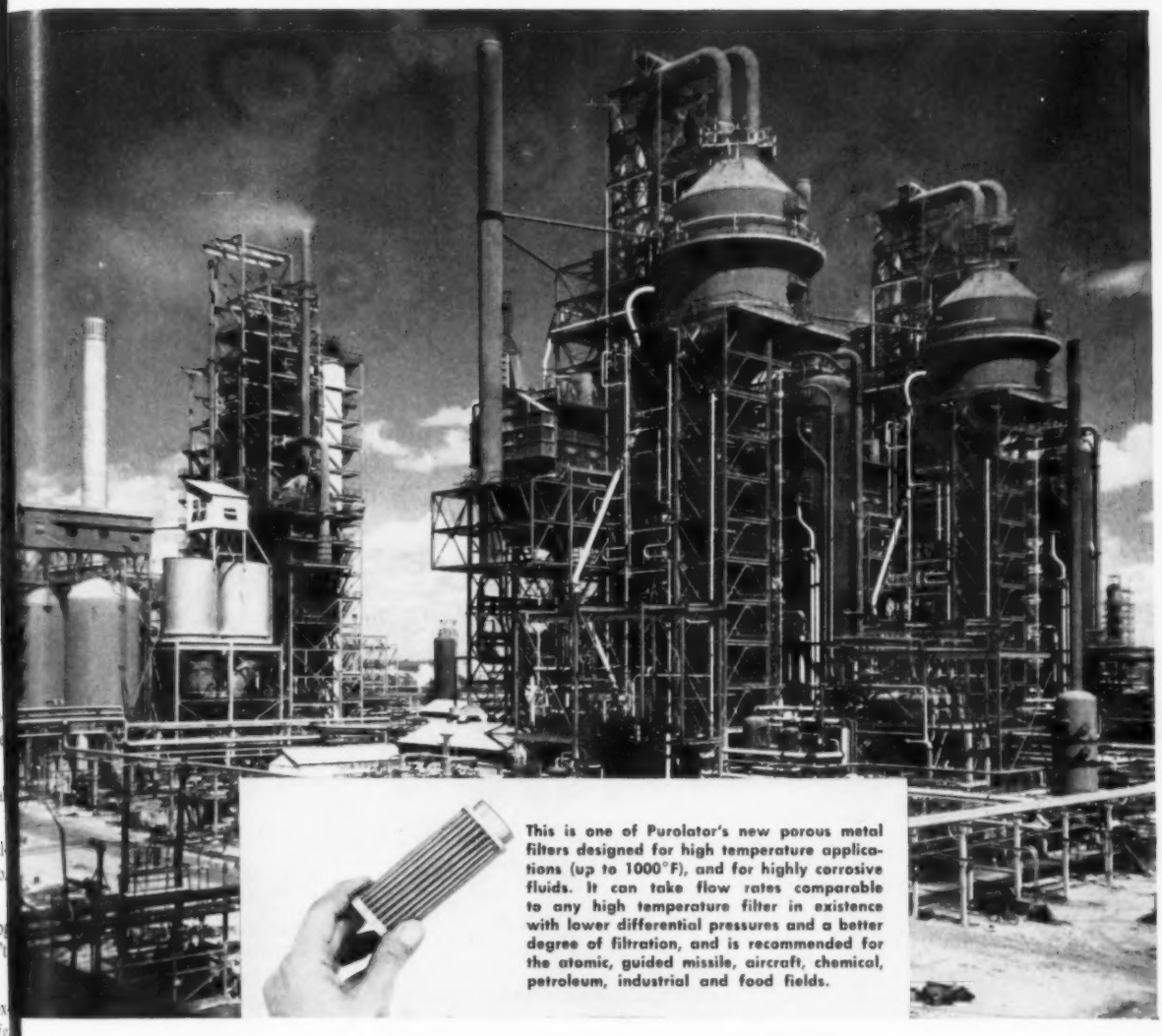
Valves, general purpose, catalog; Henry Vogt Machine Co. See adv't. p. 83.

Valves, control, data sheet; Mason-Neilan. See adv't. pp. 58-59.

Valves, gate, steel, booklet; Crane Co. See adv't. p. 180.

Valves, plug, spring loaded, jacketed, bulletin J-57; Hetherington & Berner, Inc. See adv't. p. 247.

Valves, stainless steel, folder; Cooper Alloy Corp. See adv't p. 93.



This is one of Purolator's new porous metal filters designed for high temperature applications (up to 1000°F), and for highly corrosive fluids. It can take flow rates comparable to any high temperature filter in existence with lower differential pressures and a better degree of filtration, and is recommended for the atomic, guided missile, aircraft, chemical, petroleum, industrial and food fields.

New Purolator Filters for high temperature applications

new porous metal filter has been perfected by Purolator handle gas streams up to 1000°F. It is ideal for a num- of applications in petroleum cracking – such as the moval of finely divided catalyst from the gaseous oduct stream of a petroleum catalytic cracking unit. nother is in the recovery of products which are finely ided particles and are being exhausted along with gas eams from the process.

The one-piece porous element can remove particles small as one micron in size from a wide range of ids, including such corrosive materials as nitric acid, drochloric acid, sulphuric acid, phosphoric acid and ong alkalies. It is made in a variety of diameters and gths, and its radial fin construction can be supplied in ecified depths and numbers of convolutions to give tended area within confined space. Varying flow rates are also available. Filters of stainless steel, monel, nickel and other metals can be made as required.

Controlled permeability and uniform porosity are other advantages of the new filter. They can be varied as to pore size desired. The filter has a higher degree of porosity per square inch than is available in any other high temperature, metallic filter element. It can handle differential pressures of up to 500 pounds per square inch.

Send in your problem – SI-730

Filtration For Every Known Fluid

PUROLATOR

PRODUCTS, INC.

Rahway, New Jersey and Toronto, Ontario, Canada

(To obtain more data on advertised products see page 230)

ADVERTISERS' INDEX

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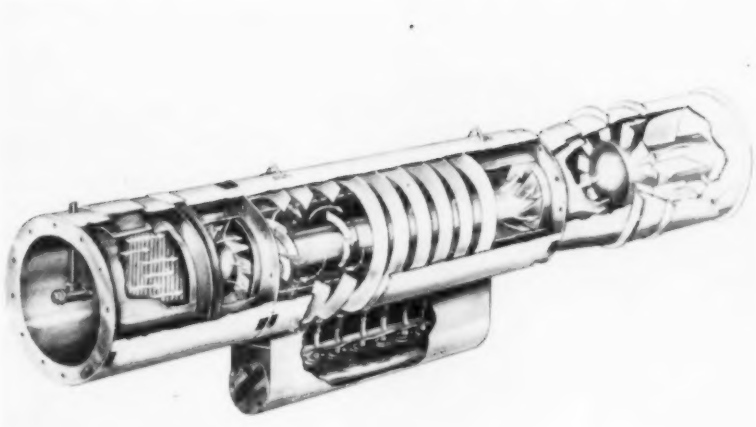


Compact collector removes small particles

Weighing up to 1/20th of a conventional dust collector, this new Microdyne collector will collect all dust particles above 5 microns, and a large portion of those below this size. Simple and extremely compact, the unit employs water and centrifugal force to produce dust-free air at outlet end.

Dust-laden air drawn into the collector impinges on a wetted, stainless steel element. A turning vane section behind the impingement section gives the dust and water-laden air a helical motion of approximately 45 degrees. As a result, the water and dust particles are driven to the walls of the cylinder.

The dust-laden water is then collected by allowing it to drain from a series of blind louvres into a sump underneath. These water exits are each closed off from one another by a circular diaphragm so that in effect each is a sealed trap that will not permit air passage. The dust-free air spirals from the center section into an axial fan and out at the rear of the unit.

Prototype models of the new collector have had capacities of up to 48,000 cfm and been successfully tested during the past year. **Joy Manufacturing Co.,** Oliver Building, Pittsburgh 22, Pa.

Circle No. **1** *on Reply Card*

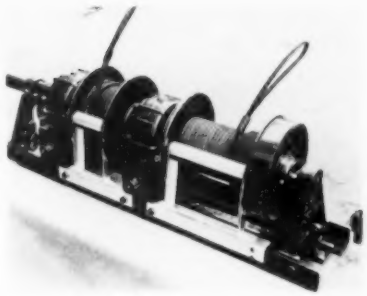
Condensate trap

. . . **for compressed air** and gas systems operates by a combination of magnetic and pneumatic forces, which gives snap open-and-shut action.

As condensate rises in the trap, the float does not move until the weight of the condensate overcomes the magnetic force holding it. Then, the float snaps open the air pilot valve. Air forces the piston assembly upward and opens the main discharge valve. When sufficient condensate has been discharged, the float drops and is snapped shut by the float arm magnet. This closes the air supply and permits the main discharge valve to close.

The piston mechanism is completely separated from the condensate to prevent damage. Pressure range of the Mag-Pneu-Power trap is from 10 to 200 psi. **Hankinson Corporation,** 951 Banksville Road, Pittsburgh 16, Pa.

Circle No. **2** *on Reply Card*

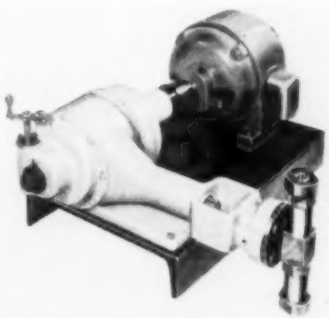


Tension roller

. . . **prevents unravelling** and cable crossing in winch lines. At the same time it provides a safeguard for operating personnel from loose cables.

The Model 0-213 can be installed on any winch simply by bolting the roller mounting bracket to the winch mounting angles—or to channels on the opposite side of the winch from which direction the line is being used. **Utility Body Co.,** 1530 Wood St., Oakland 7, Calif.

Circle No. **3** *on Reply Card*



Proportioning pump

. . . **for heavy duty** will handle 796 gph up to pressures of 16,500 psi.

The stroke length can be adjusted from zero to maximum while the pump is operating. Minimum capacity in range of pump sizes is 0.0030 gpm, with a guaranteed volumetric accuracy of 1% in all sizes. Three types of controls are available on all pump sizes. **Capacitrol Pump Co.,** 15th & Fairmount Ave., Philadelphia 30, Pa.

Circle No. **4** *on Reply Card*

(Continued on p. 234)

Ball valve

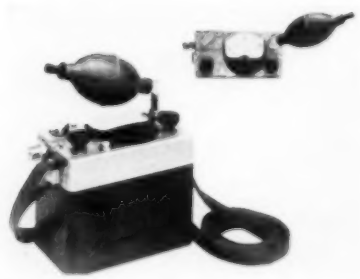
Breaks apart like pipe union

Easy maintenance is possible with this "Union-Ball" valve, which combines the function of a union and a ball valve in one unit. There is no necessity for installing a separate union, for it is possible by removing four bolts to lift the center section from the line and replace with a new valve.

With the opening in the ball and seat rings maintaining the same smooth shape as the inside of the pipe, resistance to flow with this type valve is well below that of a globe or gate valve. A simple quarter-turn opens or closes the valve, which is unaffected by a reversal of flow because the ball is fitted with twin seals, one on either side.

Metal parts of the unit may be bronze, aluminum bronze or aluminum with carbon steel. Parts of stainless steel will soon be available. Seat and seal materials may be of Buna-N, Hypalon, neoprene, natural rubber or teflon. **Worcester Valve Co., Inc.,** 20 Parker St., Worcester, Mass.

Circle No. **5** *on Reply Card*



Portable gas detector

. . . for natural gas concentrations measures from 0 up to 100% gas, and will pinpoint leaks in buried pipelines. It can also be used for testing manholes or valve boxes, as well as serving as a general-purpose combustible gas indicator.

Two ranges are built into the instrument: a low range registering 0 to 1.0 of lower explosive limit, and a 0-100% range for direct reading of gas concentration above the first scale range. Indications on the low range are obtained by catalytic oxidation on a platinum filament. Indications on the high range depend upon thermal conductivity from a non-catalytic filament.

The design of the detector permits range change without electrical switching or zero changing; a two-position valve makes the change. The unit weighs only 5 lb and is fabricated from die-cast aluminum and fiberglas. **Johnson-Williams, Inc.,** 2686 Park Blvd., Palo Alto, Calif.

Circle No. **6** *on Reply Card*

Corrosion inhibitor

. . . for cooling towers is a combination of several effective inhibitors often used separately. The combination offers an effective product over a wide range of pH conditions.

Nalco 360 comes in the form of 3-in. diameter briquettes, each weighing about 1 lb. In applying the chemical to a cooling tower, the water is bypassed in a feeder where the briquette is dissolved. Or, the briquettes may be dissolved by hanging in a wire basket suspended in the cooling tower basin.

This synergized inhibitor should not be used in the treatment of potable waters nor where contamination of potable water may occur. The most easily identifiable inhibitor in the blend is chromate. **National Aluminate Corp.,** 6216 West 66th Place, Chicago 38, Ill.

Circle No. **7** *on Reply Card*

Induction heater

. . . both preheats and stress relieves in one continuous cycle. There is no need to move welded pieces for furnace treatment.

When the preheat temperature has been selected, the controlling instruments heats to this temperature and holds it accurately. After the weld is completed, the instrument automatically starts the previously desired stress program. A permanent, accurate record of the entire program is provided on the instrument chart to allow efficiency and usage calculations to be made as desired.

A 400-cycle current is used instead of the commonly used 60-cycle because, for a given coil, current hysteresis and eddy current losses are increased. Temperature rises faster as the frequency of the alternating current is increased, thus permitting lower amperage through the induction coil. This reduced current eliminates excessive heat in the coil itself and eliminates the need for heavy cables and water-cooled induction cables. **Hobart Brothers Co.,** Troy, Ohio.

Circle No. **8** *on Reply Card*

(Continued on p. 236)

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How Well Do You Write?—10 keys to better, more easily-understood memoes, letters, reports. By S. D. Boynton. 2 pages. April, 1956 Reprint **R53** $0.10

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Gaskets—How to Choose and Use Today's Gaskets in Today's Equipment, a special 16-page report by Ron Cannon: what a gasket is, how it works, types of gasketed joints, factors in design, selecting materials, how to get the most out of your gaskets. Reprint **R43** $0.50

'Instrument Charts' Track Costs—use of control charts by British American Oil Co. tells when your operating costs are out of line. 8 pages. October, 1956 Reprint **R36** $0.25

Drafting Production Manual—for better and faster drafting, including a do-it-yourself slide rule for flange and fitting data. 24 pages. July-October, 1956. Reprint **R31** $1.25

Hydrogen Processing—An Appraisal of Its Use in the Refinery, by Robert L. Davidson: what it is, how it works, what it does, who is using or planning to use it, processes and catalysts. 24 pages. December, 1956 Reprint **R30** $0.75

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EDS 6, **Heat—and Its Transfer** R19
EDS 7, **Vapor Pressure** R22
EDS 8, **Distillation Fundamentals** R25
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EDS 10, **Tank Capacities—II** R29
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EDS 16, **Instrument Terminology —A-F** R45
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Fabricated in special shapes to exact specifications. Under fatigue of severe operating conditions, they are superior in sealing efficiency, longevity and ability to retain physical and chemical properties. These gaskets are built for specific purposes in strict accordance with customers' requirements or templates. When used for recommended services, they completely satisfy and give extra long life. A group of specially constructed metallo Gaskets are made for heat exchangers with metal jackets and asbestos filler. These gaskets, including irregular shaped gaskets for any process equipment, are readily made in several different styles and shapes, in any metal and in sizes limited only by transportation facilities. These gaskets are also cut from solid sheet metal.

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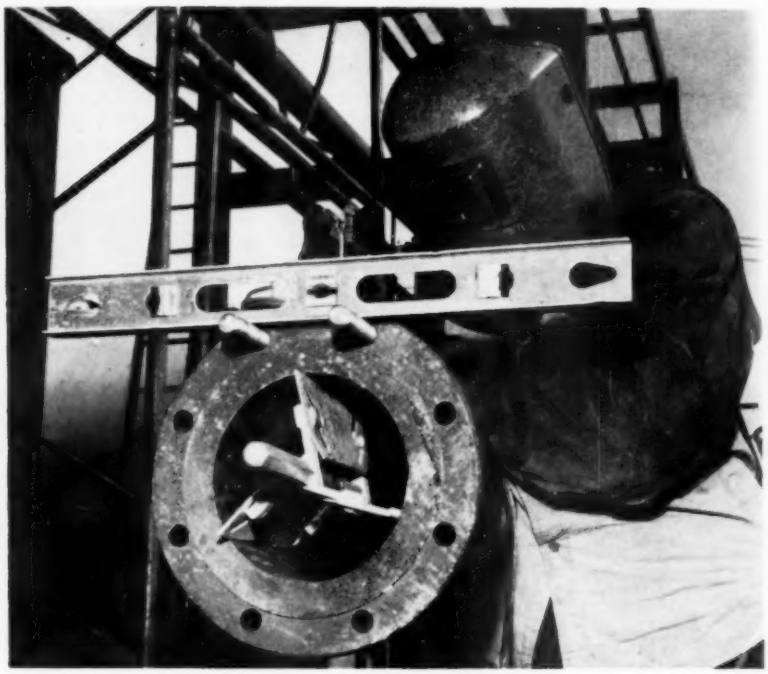

Line-up clamp

Positions weld neck flanges

This new tool permits a quick lineup of weld neck flanges or stub ends with the pipe. It is inserted into the pipe-flange, which is placed on the pipe with the flange projecting out. A few turns of the mandrel will bring the three centering blades in contact with the pipe and fitting. The flange may then be rotated for final leveling before the tool is firmly clamped.

The Line-O-Tool is available for pipe sizes ranging from 3 to 20 in. Four separate units span this range—one from 3-4 in., another from 6-12 in., from 12-16 in., and another from 16-20 in. Blades for the 6-20 in. sizes are interchangeable. **Line-O-Tool Co.,** 1927 Bank of the Southwest, Houston 2, Texas.

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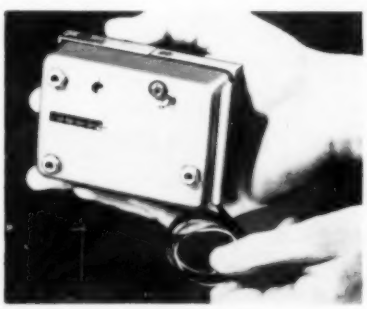

Linear integrator

. . . **continuously integrates** recorded values and provides a direct or remote reading of the integrated value.

Adaptable to strip chart recorders, or for use on any recorder which presents the variable as a shaft displacement or position, the Librascope Model 25 Linear Integrator uses a ball and disc mechanism. The integrated, area or averaged computation of flow, temperature or pressure values are counted and presented on the face of the unit—or an output pulse transmits this reading to a remote recorder or counter. **Librascope, Inc.,** 808 Western Ave., Glendale, Calif.

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Gas-filled "O" rings

. . . **improve sealing** at high temperatures and have greater resilience with increased flange deflection.

Standard 0.010 stainless steel "O" rings are filled with gas at pressures ranging from 500 to 3,000 psi at room temperatures. The effect of the gas is to offset the inherent loss of the metal strength at elevated temperatures. Al-

ready in use in missiles and aircraft turbine where temperatures exceed 1000°F, these new sealing rings have potential uses in high-temperature processing vessels. **Advanced Products Co.,** North Haven, Conn.

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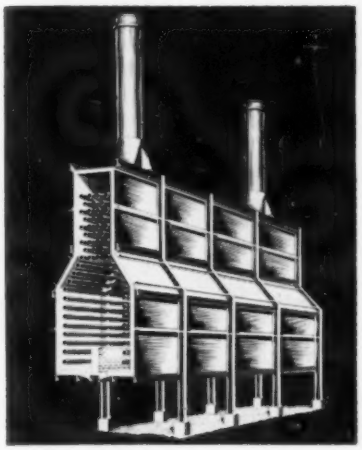

Standardized heater

. . . now at lower cost, can be purchased prefabricated for field erection or completely shop-assembled.

Previously furnished as special custom-built units, this Econotherm tubular heater is designed for heating oils and chemicals below decomposition temperatures. It is available in three configurations, and accommodates three heating requirements: 8 - 17 million Btu/hr, 17 - 30 million Btu/hr and over 30 million Btu/hr. Special units for other requirements can still be obtained on specific order. **Selas Corporation of America,** Dresher, Pa.

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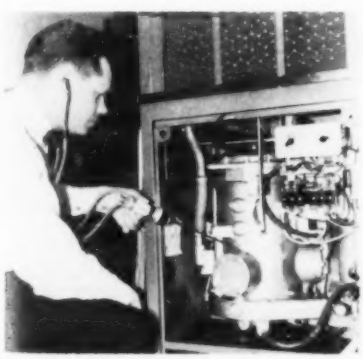

Industrial stethoscope

. . . detects mechanical trouble before it becomes too serious. Bearing misalignment, uneven wear, leaking fluids or any developing trouble spot that

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141 DUCON CYCLONES INSTALLED FOR CATALYST RECOVERY

High Efficiency Attested by Leading Oil Refineries...

DUCON CATALYST RECOVERY CYCLONES

Recovery of valuable catalyst in regenerator and reactor systems makes a big difference in the efficiency and costs of oil refining. Ducon Type SDC Cyclones, with the exclusive helical inlet feature, have proved themselves the world over for their dependable high operating effectiveness, and maximum catalyst recovery for constant reuse.

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FLUID CATALYTIC CRACKING • FLUID COKING
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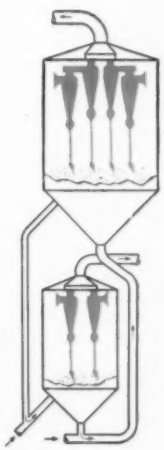

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THE Ducon COMPANY INC.

147 EAST SECOND STREET • MINEOLA, L. I., NEW YORK

CYCLONES • CENTRIFUGAL WASH COLLECTORS • TUBULAR CLOTH FILTERS • DUST VALVES

(To obtain more data on advertised products see page 230)

emits a noise can be traced down with this industrial doctor's tool.

The Airsonic requires no outside power but amplifies any sound received, and then selectively analyzes it through the skill of the user. A turn of the knob on the instrument permits tuning out extraneous sounds in locating trouble in machinery. Static objects may be compared by tapping on them and comparing their vibration to detect cracks or holes. Manufactured in England, this instrument is distributed in the U.S. by **M. Paquet & Co., Inc.,** 17 Battery Place, N.Y. 4, N.Y.

Circle No. **13** *on Reply Card*

Wrench calibrator

. . . **for impact wrenches** will also measure bolt tension. Model ML measures bolt tensions from 0 to 100,000 lb, in bolt sizes ranging up to 1¼ in.

This unit is equipped with a special shock resistant gage-saving unit which protects the gage through a spring mounting. It employs a hydraulic principle of operation, permitting its use without special training. **Skidmore-Wilhelm Mfg. Co.,** 442 South Green Road, Cleveland 21, Ohio.

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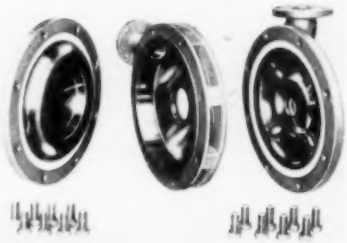

Glassed pump

. . . **prevents metal contamination** of any pumped product. All inner surfaces of the pump are glassed and will

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MERCURY ACTUATED
Temperature Indicating Instruments

4½" DIAL THERMOMETERS

Made in 3 types to suit any requirements. Rigid stem, wall or flush mounted, 11 inches of scale reading. Interchangeable with standard industrial separable sockets. Stem can be placed at any angle and case can be rotated to any readable position.

RECORDING THERMOMETERS

Twelve inch die-cast aluminum case with black or white wrinkle or satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 +950°F or Equivalent in °C.

INDUSTRIAL THERMOMETERS

Red-Reading Mercury—Extruded brass case — chrome finish. Ranges —40 + 950°F or Equivalent in °C.

RED-READING MERCURY LABORATORY THERMOMETERS

Thoroughly annealed for permanent accuracy. Complete line A.S.T.M. and fractional division types.

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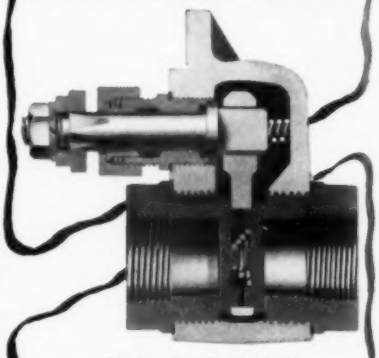
FULL-FLOW
Okadee
VALVES
NON-LUBRICATED



POSITIVE STOP

FOR
- Steam
- Air
- Ammonia
- CO_2
- Gasoline
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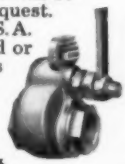
Available in Stainless Steel or Steel, Chemically Nickel Coated

You can select Okadee Valves for flow by pipe size — and get full-flow and positive shut-off with virtually any liquids and gases.

Quick-opening, metal-to-metal disc valves and seats require no lubrication — virtually no maintenance for hundreds of thousands of operations . . . Real valve *performance* and *service.*

FACTS AND FIGURES

. . . on Okadee Valves will be sent promptly on request. Sizes ½" to 8"; A.S.A. dimensions; screwed or flanged. Valve seats and discs Stellite or stainless steel; your choice of operators.



• Write for Bulletin CP6

Okadee COMPANY
332 SOUTH MICHIGAN AVENUE
CHICAGO 4, ILLINOIS

resist all organic and inorganic acids (except hydrofluoric) and alkalies up to pH 12 at 212°F.

A special three-piece construction was developed; the casing, suction piece and casing cover are separate glassed parts which fit together. Flow qualities are improved by the smoothness of the glass coating, which has a surprising structural strength. The glass and iron are solidly bonded at high temperatures and the compressive forces built up during cooling have a toughening effect.

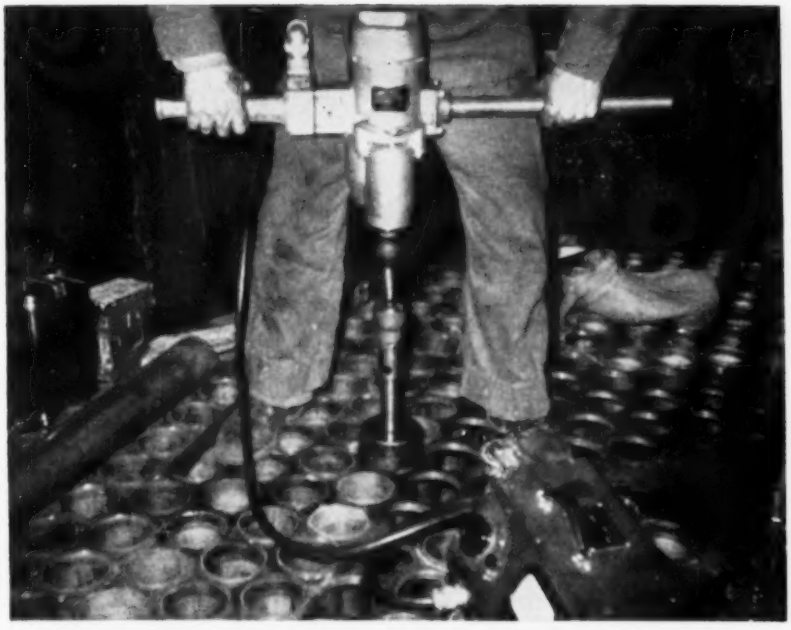
The new pump is offered in four different sizes and capacities up to 700 gpm and for heads to 140 ft. Either a mechanical seal or a stuffing box may be used, with seals available for suction pressures up to 150 lb and temperatures to 350°F. **Goulds Pumps, Inc.,** 29 Black Brook Road, Seneca Falls, N.Y.

Circle No. **15** *on Reply Card*

Photoelectric relay

. . . **can be plugged into** any 120-volt line, and works without tubes or transistors. Ordinary 40-w household lamps can be used as the light source in setting up a photocell system. A distance of 5 ft can be monitored by this system.

The photocell and relay will react to a light interference of up to 60 cycles/sec, and can detect interfering objects as small as 1/32 by ⅛-in. These miniature photoelectric relays are designed for industrial applications of counting, smoke detection, door control and



850 tubes rolled in less than 5 hours!

AIRETOOL Automatic Tube Expansion Control System simplifies and speeds accurate tube rolling!

A large coppersmithing company* recently faced one of the biggest tube rolling and expanding jobs of its kind when they had to roll 850 4 in. OD x 13 gage copper tubes in a limited time. Using AIRETOOL'S Automatic Tube Expansion Control System, they rolled those tubes at a rate of one every twenty seconds . . . completed the job in *less than five hours!*

You too, can shorten tube rolling time immensely . . . eliminate costly over-rolling, over-expanding and distortion of tube sheets . . . with AIRETOOL'S Automatic Tube Expansion Control System. Ask for an ON-YOUR-JOB demonstration, today. *Name upon request

SOLVE ALL YOUR TUBING PROBLEMS, FROM INSTALLATION TO REMOVAL, WITH AIRETOOL TUBE MAINTENANCE EQUIPMENT

CONDENSER CLEANERS

Outside mounted . . . direct or gear driven. Powerful . . . fast . . . lightweight. Clean lightly scaled or completely plugged tubes to 1". Built-in flushing system cools drill, removes chips.

CONDENSER TUBE EXPANDERS

Parallel rolling . . . self-feeding . . . ball bearing thrust collar. Roll tight accurate tube joints to uniform expansion and tightness with maximum bonding.

TUBE CLEANERS

Powerful . . . fast cutting . . . quickly, completely remove hardest deposits. Air Driven motors in wide range of sizes and speeds.

Write for illustrated literature, (Bulletin 60), showing AIRETOOL'S complete line of tube maintenance equipment.

AIRETOOL
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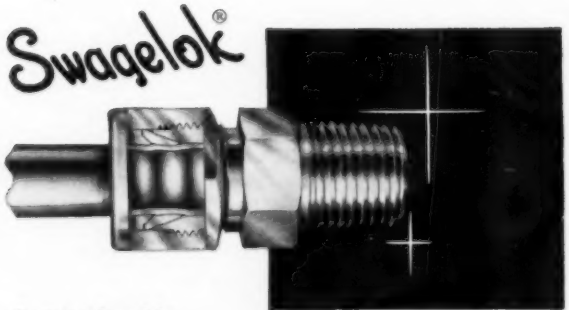
BRANCH OFFICES: New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge.
REPRESENTATIVES in principal cities of U. S. A., Canada, Mexico, South America, England, Europe, Puerto Rico, Italy, Japan, Hawaii.

EUROPEAN PLANT: Vlaardingen, The Netherlands. CANADIAN PLANT: 37 Spalding Drive, Brantford, Ontario.

(To obtain more data on advertised products see page 230)

Only one name identifies the finest in fittings

Swagelok®



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TUBE FITTINGS

CRAWFORD FITTING COMPANY

884 East 140th Street

Cleveland 10, Ohio

many other uses. **Tri-Tronics Co.**, 2607 St. Charles Road, Bellwood, Ill.
Circle No. **16** *on Reply Card*

Aluminum elbow

. . . **protects insulation** on insulated pipe elbows. Deep-drawn from 0.020-in. aluminum, #3003 alloy, it can be obtained in both 45° and 90° shapes. A moisture barrier is applied at the factory.

These Ell-Jackets are two-piece and designed to fit snugly over insulated elbows. Aluminum metal sheet screws are used to anchor the two pieces together. Strap bands can be used to mate the elbow with jacketing on straight lengths of insulated pipe. **Childers Manufacturing Co.,** P.O. Box 7467, Houston 8, Texas.
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Cold plastisol

. . . **for spraying** on vertical metal surfaces will protect them against chemical corrosion. It can be used especially for those metal parts which

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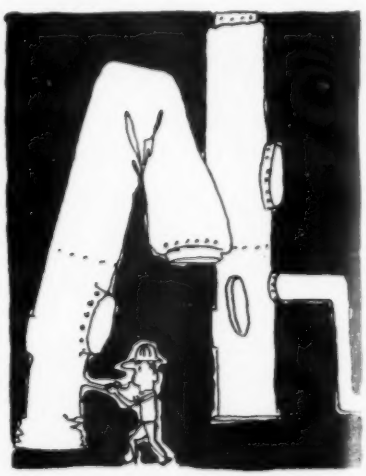

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British Petroleum Co., Ltd.
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Sun Oil Company
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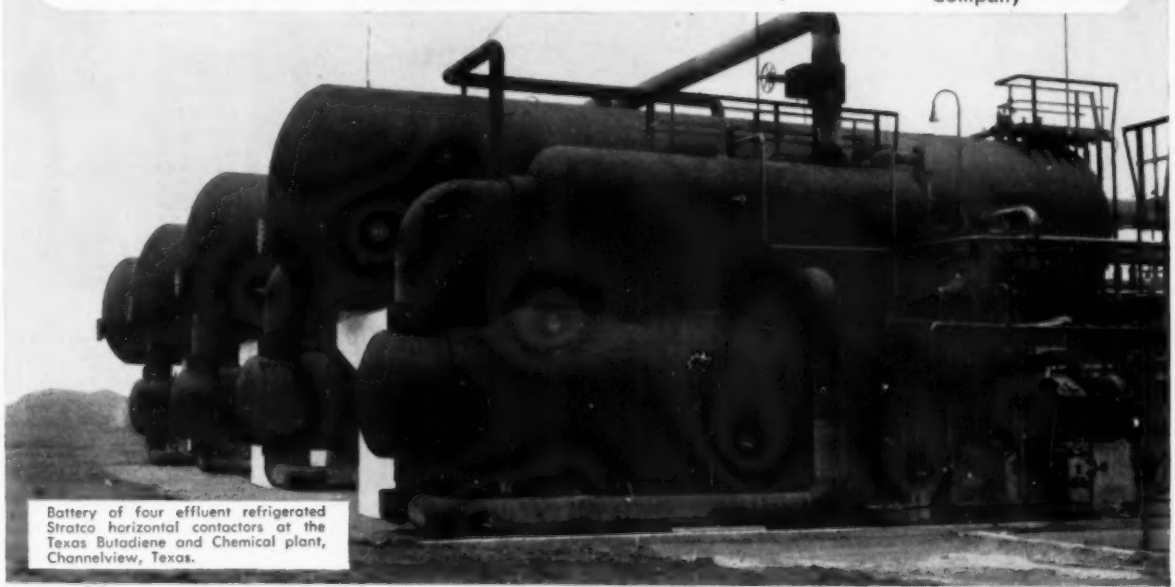


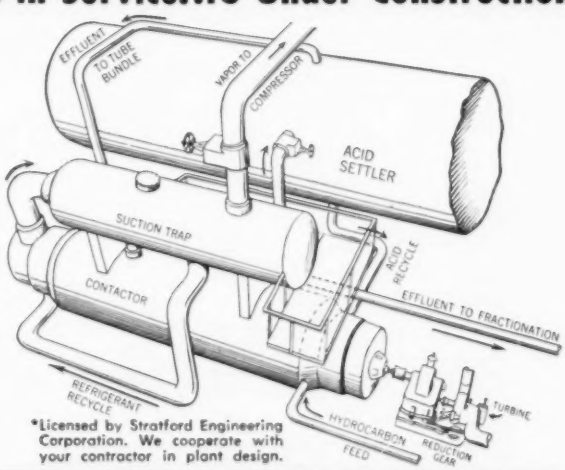
Battery of four effluent refrigerated Stratco horizontal contactors at the Texas Butadiene and Chemical plant, Channelview, Texas.

23 Effluent Refrigerated Contactors in Service..18 Under Construction

(In addition to 139 contactors furnished for alkylation service prior to effluent refrigeration development.)

HERE IS WHY

This process, using Stratco effluent refrigeration and the new horizontal Stratco contactor, produces high quality alkylate with unusually low investment and plant operating costs. Inquiries invited.



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Representatives
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STRATFORD ENGINEERING Corporation

612 West 47th St. — PETROLEUM REFINING ENGINEERS — Kansas City 12, Mo.

keeping the giant on stream

Tidewater Associated Oil Company's giant Delaware City refinery houses the most complete operating and control information system ever installed in a process plant. Vital information from more than 5,000 variables of temperature, pressure, flow and equipment condition is channeled — hourly or on demand — to the men who must know, from process operators to management.

Panellit, Inc. is proud to have taken part in the construction of this giant refinery — from the design, fabrication and installation of the refinery's nine process control rooms to the continuing contractual maintenance of all instrumentation by Panellit Service Corporation. Also, we're proud to have joined with Tidewater management and C. F. Braun & Co. engineers in this giant stride toward quality of product and process efficiency.

Instrumentation at Tidewater typifies the comprehensive design, fabrication, installation and maintenance services offered by Panellit, Inc. through three divisions—Panellit, Panascan and Panalarm—and the subsidiary—Panellit Service Corporation. Specific information is available to you through direct inquiry.

PANELLIT **PANELLIT, INC.** *7429 N. Hamlin Ave., Skokie, Ill.*
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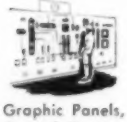
Engineered Information Systems for Industry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Map & Listing
1957 Petroleum Refineries—
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Just circle Reprint R46 on Reader Service Card, pages 231-232
29 x 23 inch two-color wall map—over 425 listings and map locations
Cost, 25¢ each—discounts for 25 and more.

cannot be dipped, but which can be heat treated.

Quel-Spray is a true plastisol of polyvinyl chloride and has advantages over PVC sprays which are modified organisols or plastisols. It requires no thinner, can be left in the gun overnight, and loses no thickness from wet to dry film when cured at approximately 350°F. **Quelcor, Inc.,** Front & Broomall Sts., Chester, Pa.

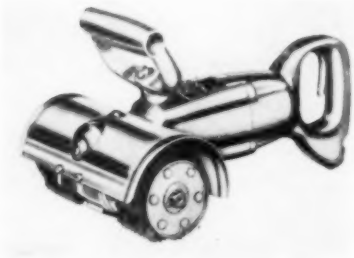
Circle No. **18** *on Reply Card*

Pocket pH meter

. . . **for on-the-spot checking** can be operated with one hand, leaving the other free for notations. This lightweight meter—2 lb—is just 6 in. long, 3 in. wide and 2 in. deep. It has a range of 2 to 12 pH, with readability to 0.1 pH. Power for the small instrument comes from six flashlight-type batteries.

A combination glass and reference electrode is used. The two-tone case is made of acid-resistant melamine plastic, the dial face is polystyrene. Scientific Instruments Div., **Beckman Instruments, Inc.,** Fullerton, Calif.

Circle No. **19** *on Reply Card*



Cleaning tool

. . . **removes rust, scale, paint** and other accumulations from almost all surfaces with a pneumatic-powered rotor. A slip fit on the spindle of the

SPARKLER
horizontal plate
FILTERS

Undisputed First Choice

with engineers who have had occasion to thoroughly test this type of filter. Shown here are structural features that are the result of over 30 years experience in building this one filter. If it could be made better or cheaper Sparkler would have made it that way long ago.

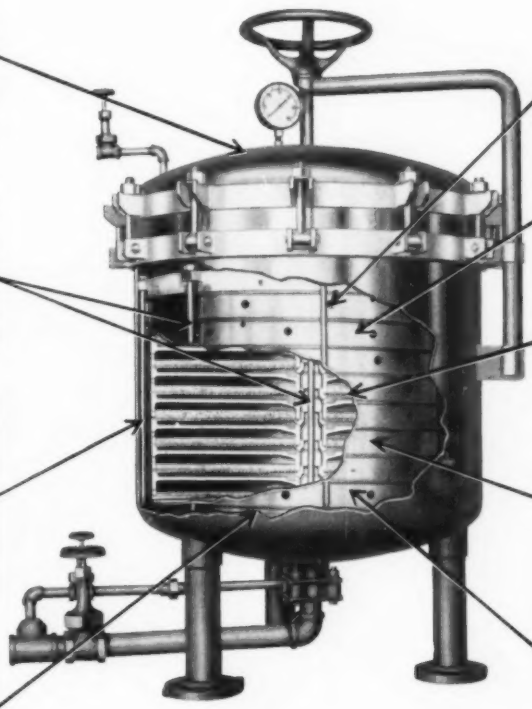
Aloysius C. Kracklauer
Originator of the Horizontal Plate Filter

A.S.M.E. designed construction is standard for pressures up to 60 lbs. on all filter tanks.

Plates sealed independently at center and periphery to assure positive seal.

Plates sealed independent of tank closure to secure a positive seal for both filter plates and for tank cover.

Scavenger plate supported by re-inforced flat bottom tank.



Cartridge plate assembly—removable indepently of tank.

Heavy solid plate rings precision machined.

Heavy perforated sheet metal support for filter paper.

A more positive filter seal is obtained when hydraulic pressure is applied to plates externally rather than internally.

Plate designed to reduce flow friction to a minimum.

The Sparkler, original exclusive horizontal plate design and flow principle, has never been equalled for efficiency and dependability in filtering with any and all types of filter aids. The cake maintains its original position as formed regardless of pressure fluctuation flow rate or viscosity. No break-through is possible, even with a complete shut down of the filter. Filtering can be resumed with perfect safety at any time. With Sparkler plate construction a completely sanitary filter can be furnished.

SPARKLER FILTERS

SPARKLER MANUFACTURING CO. MUNDELEIN, ILLINOIS

Sparkler International Ltd.—Manufacturing plants in Canada, Holland, Italy and Australia.

REPRESENTATIVES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

(To obtain more data on advertised products see page 230)

AMOCO

WILL ACHIEVE
lower maintenance
AND
operating costs
AT THEIR REFINERIES

with the
Alumicoat
molten aluminum process

The Alumicoat Molten Aluminum Process will substantially reduce down time and expense for repairs and replacements by preventing high temperature hydrogen-sulfide corrosion and scaling in hydro-desulfurizing equipment.

In addition, costs will be reduced further by the use of low cost, low alloy steels which, when "ALUMICOATED", obtain the necessary resistance to high temperature hydrogen-sulfide corrosion.

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Please send ALUMICOAT brochure and complete information on the ALUMICOAT PROCESS.

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rotor prevents any damage to the rotor when in use.

Air entering the governor housing pushes a plunger head close to the face of the jet of air. This movement allows just the proper amount of air to enter and keeps the tool operating efficiently. The speed of the tool can be varied plus or minus 200 rpm by adjusting the stem in the plunger.

When operated at 90 psi air pressure, the motor unit develops about 1 hp. Maximum air required under load is 42 cfm; for free running, air required is 20 cfm. **Aurand Mfg. & Equipment Co.,** 1210 Ellis St., Cincinnati 23, Ohio.

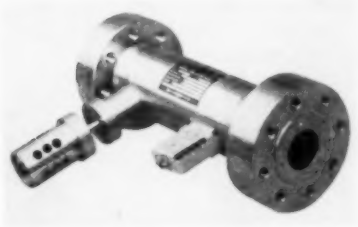
Circle No. **20** *on Reply Card*

Hydraulic slide rule

. . . solves problems for pipe and open channel flow. One side of the slide rule is based on the Hazen-Williams formula for pipe flow, allowing for a wide range of surfaces. Using four scales will give a solution to this type of problem; scales in black give values in cu ft/sec, while those in red give cu meters/sec.

The other side of the hydraulic slide rule is based on the Manning formula for open channel flow. The "n" used is the coefficient of the Kutter formula. The slide rule is made of PVC plastic with chromium plated fittings. **Paterson Engineering Co.,** Windsor House Kingsway, London, England.

Circle No. **21** *on Reply Card*



Mass flowmeter

. . . measures true mass flow rate at temperatures ranging from —423°F to +1000°F, of liquids, vapors, gases or multiphase combinations.

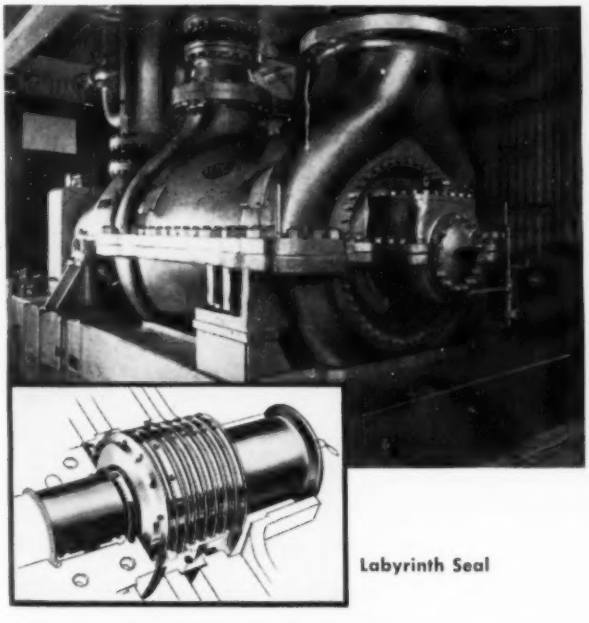
The Digimaf uses speed of rotation of an impeller as a signal proportional to mass flow rate. The basic reference is a constant mass suspended on an arm, which of course does not change with temperature. The change in the length of the supporting arm compensates for the change in diameter of the pipe with temperature. By taking the output of the signal in digital form

(To obtain more data on advertised products see page 230)

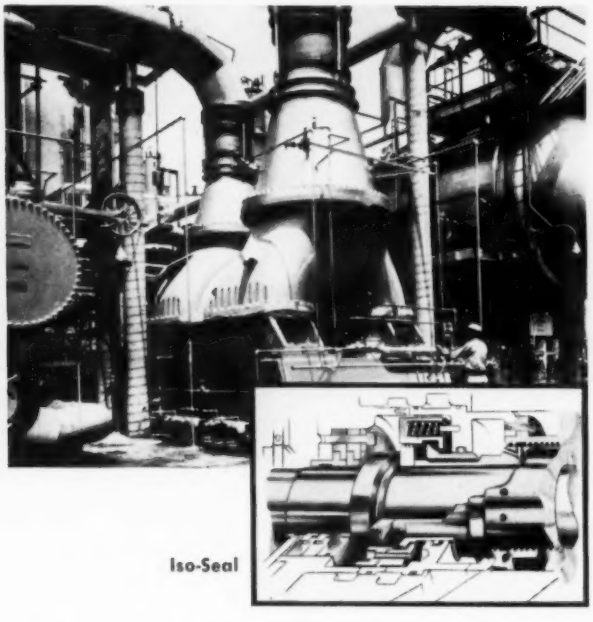
Which is the best way to seal air and gases?

That depends on the type of gas, its pressure, its toxicity and other factors. No matter what the sealing problem, Carrier Centrifugal Compressors are designed with the right seal for the specific job. For example, the labyrinth seal is right for handling air or other non-toxic, non-explosive or inexpensive gases at moderate to low pressures. At the other extreme, an iso-seal is the solution for holding various hydrocarbon gases, especially if the gas must not be contaminated by the sealing fluid or vice versa. For complete information on various compressor seals, call your nearest Carrier office or write Carrier Corporation, Syracuse, New York.

Carrier



Labyrinth Seal

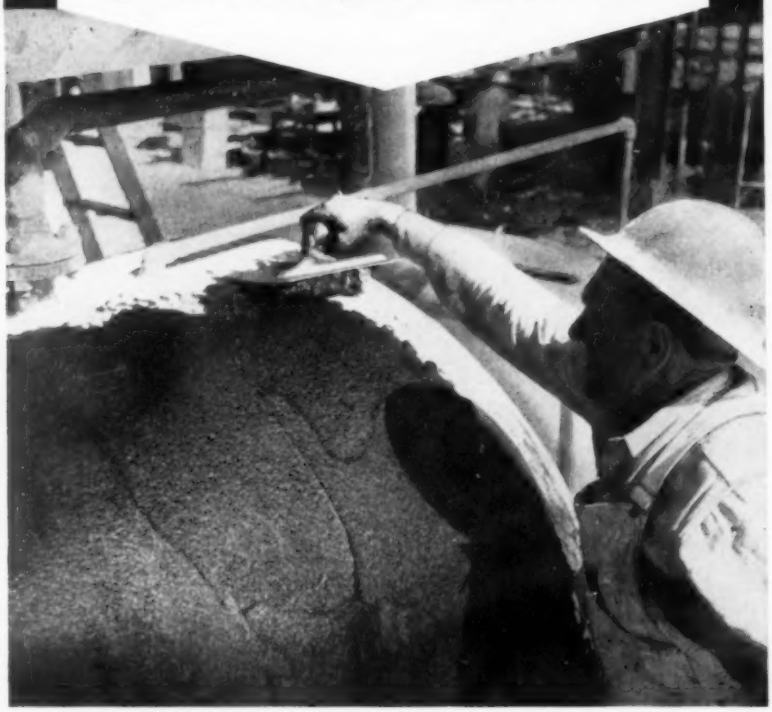


Iso-Seal

To protect against air leakage, a labyrinth seal is used on the shaft end of this Carrier Centrifugal Compressor located in a midwest refinery. The compressor is used to supply air to a fluid catalytic cracker. This type of seal consists of a lead-lined steel shell which makes a rabbitt joint with the compressor casing. Multiple projections, alternately high and low on a sleeve attached to the shaft, cut their own grooves into the stationary lead lining during the run-in period.

To separate the gas stream from the seal oil system, an iso-seal is used in this Carrier Axial which handles butadiene in a southwest plant. In seals of this type, seal oil, supplied at slightly higher pressure than suction, is kept from gas stream by a floating carbon ring. The seal oil pressure is then broken down to atmosphere through a series of narrow floating babbitt steel rings; the number depending upon the pressure breakdown. On shutdown, this is a positive seal.

Laykold® WEATHERCOAT
protects exposed insulation



INSULATION on towers, tanks and exchangers must be kept DRY. If moisture gets through, the efficiency drops.

Modern refinery and plant design places many major insulated vessels "in the open." You can maintain the efficiency of your insulation with easy-to-apply Laykold Weathercoat.

Weathercoat is a fibrated asphalt-base material of easy troweling consistency that dries to a black, remarkably tough and tenacious coating. A majority of the leading refineries are regular users of Weathercoat.

A new product: Mastic Weathercoat, a bodied material, for use wherever economy demands the application of a *single*, thick layer.

Write today for our free illustrated brochure, entitled "Laykold Weathercoat for Insulation Protection."

American Bitumuls & Asphalt Company

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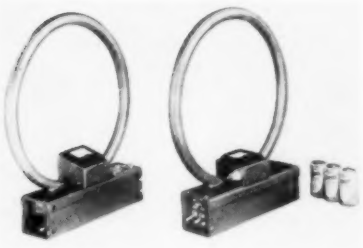
Baltimore 3, Md. · Mobile, Ala. · Inglewood, Calif. · St. Louis 17, Mo. · San Juan 23, P.R. · Oakland 1, Calif. · Perth Amboy, N. J. · Cincinnati 38, Ohio · Tucson, Ariz. · Portland 7, Ore.

it is made insensitive to temperature.

This digital mass flowmeter may be powered by 115 volts, 60 cycle current, and can be used in test labs, pipe lines, industrial uses and cryogenic fluid manufacture. **Inertial Instruments, Inc.,** 1738 Colorado Ave., Santa Monica, Calif.

Circle No. **22** *on Reply Card*



Pipe detector

. . . locates buried pipe, valves or other metallic objects. All parts for this compact, miniaturized detector are contained in two small containers, each weighing 4 lb. Transistors, instead of vacuum tubes, make operation on three flashlight cells possible.

The received signal is not only audible on earphones but is also presented visibly on a panel instrument. The transmitter and receiver units are separate units and may be operated remotely from each other to trace out pipes. It is possible to mount them both in a hand-carrier for detecting metallic objects. **Oltron,** 6 Hillside Blvd., Daly City, Calif.

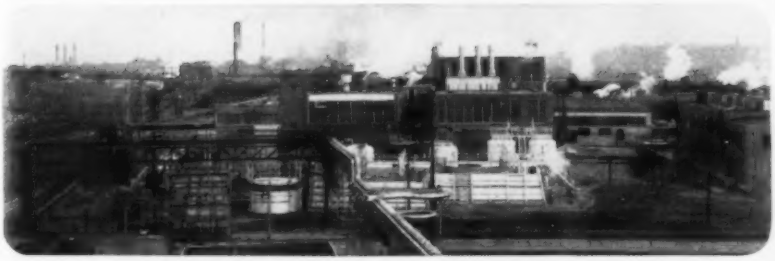
Circle No. **23** *on Reply Card*

Rock breaker

. . . for covering pipelines reduces windrowed rock up to 24-in. diameter in place, and can be towed by any 50 hp tractor. Up to 400 cu yd/hr of rock fill can be reduced for aggregate.

The machine employs 22 free-swinging hammers mounted on a common shaft. Rotating at high speeds, these 47-lb hammers break rock along its natural cleavage lines. A variable speed

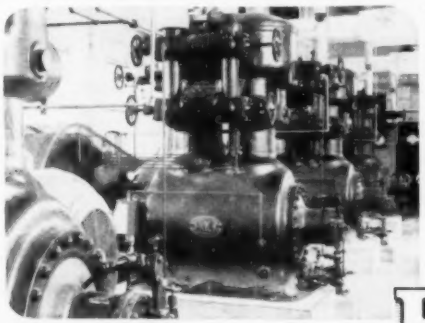
(To obtain more data on advertised products see page 230)



GOODYEAR'S NEW CHEMIGUM PLANT EQUIPPED WITH FRICK REFRIGERATION

This versatile plant, just completed at Akron, makes many types of rubber, latices and plastics. The big reactors, each holding 3000 gallons, are lined with glass; each is cooled with seven banks of glass-coated ammonia coils of the patented Frick direct-expansion design.

These coils, with their control system, enjoy a world-wide preference for use in chemical reactors.



Frick ammonia compressors at Goodyear's new plant in Akron, Ohio.

Four Frick compressors of 12 in. bore and 12 in. stroke, together with a 5 by 5 machine, carry the refrigerating load under automatic and semi-automatic controls.

When you want the most durable and efficient refrigerating equipment, whether for air conditioning, process work, ice making, quick freezing or other cooling service, specify "Frick". Literature and estimates on request.

DEPENDABLE REFRIGERATION SINCE 1882

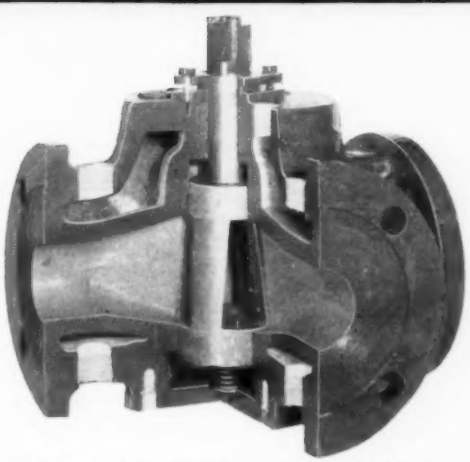
FRICK CO.

WAYNESBORO, PENNA., U. S. A.

H&B ESTABLISHED 1887

Jacketed Spring Loaded PLUG VALVES

- 2-WAY OR STRAIGHT SPRING LOADED
- 3-WAY SPRING LOADED
- ANGLE SPRING LOADED
- AIR CYLINDER OPERATED SPRING LOADED—*all sizes and types*



LONG ON SERVICE . . . SHORT ON MAINTENANCE

H & B's new fully jacketed spring loaded plug valves feature an inverted tapered plug inserted and lapped into the housing from the bottom of the valve—then spring loaded. The spring wedges the plug to a perfectly tight seal, eliminating troublesome leaks. Easy to operate—no big handwheel . . . no freeze . . . no "breaking loose" necessary. Easy to clean. Made in two port or multi port design, with any special stop arrangement desired.

Bulletin J-57 sent on request

HETHERINGTON & BERNER INC., 715 Kentucky Ave., Indianapolis 7, Ind.

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(To obtain more data on advertised products see page 230)

add complete

CORROSION RESISTANCE

Trailer Tank lined with KEL-F Laminate for large commercial hauler of acids, alkalies, oxidants and solvents.

...with **KEL-F LAMINATE** lining

100 gal. Tank lined with KEL-F Laminate handles acid fluorides.

Reactor-pot, cover and nozzles lined with KEL-F Laminate.

Make ordinary equipment—tanks, vessels, pipe, chutes, ducts, hoppers, vats, drums—resistant to gases and liquids as corrosive as fuming nitric acid—with KEL-F Laminate.

TOUGH—SHATTERPROOF—KEL-F* Laminate is a durable, abrasion resistant, chemically inert fluorocarbon plastic, bonded to a glass-cloth backing for maximum adhesion. It is readily cemented to any material of construction—metal, wood, concrete, etc.—and over a variety of contours.

HEAT-SEALED SEAMS—KEL-F being a thermoplastic resin, seams may be "welded", on the job by the thermal pulse technique, into a continuous lining having zero water absorption and extremely resistant to acids, alkalies, oxidants and solvents at temperatures up 350°F.

CERTIFIED APPLICATORS—KEL-F Laminates are manufactured by the United States Gasket Company, pioneers and leaders in fluorocarbon plastics, and are available for installation by certified applicators. Write for further information and the name of applicator nearest you.

UNITED STATES GASKET COMPANY
Camden 1, New Jersey

*Trademark, Minnesota Mining & Mfg. Co.

4-inch pipe coupling lined with KEL-F Laminate for sulfuric acid service.

United States Gasket *Plastics Division*
OF THE GARLOCK PACKING COMPANY

transmission takes care of varying hardness. An enclosed, silent-chain drive connects the hammer shaft and the drive shaft. **Bros Inc.**, 1057 Tenth Ave., S.E., Minneapolis 14, Minn.

Circle No. **24** *on Reply Card*

Free trade literature

Atmospheric emissions

. . . from oil refineries: *Interim Report of the Joint District, Federal, and State Project for Evaluation of Refinery Emissions* reports on the progress of studies under way in Los Angeles. Included are discussions of plumes, cooling towers, air blowing, valves, flanges, storage tanks and catalytic cracking units—and their effect on the problem of air pollution in that region. Limited copies of the report are available from Mr. Carl V. Kanter, Los Angeles County Air Pollution Control District, 434 South San Pedro St., Los Angeles 13, Calif.

Do not use Reply Card

Catalyst testing

. . . by many approved methods: *Test Methods for Synthetic Fluid Cracking Catalyst* is a comprehensive, 80-page bulletin discussing methods for analyzing this kind of catalyst. Complete with charts, diagrams and calculation sample methods, this manual lists many old and new methods for determining density, activity, resistance to attrition, pore characteristics, and particle size distribution of fluid cracking catalysts. It will serve as a guide and reference for those who are interested in this subject. American Cyanamid Co., Refinery Chemicals Dept., 30 Rockefeller Plaza, N.Y. 20, N.Y.

Circle No. **25** *on Reply Card*

Controlled volume pumps

. . . for precise metering and pumping of corrosive liquids against pressure: *Bulletin No. 553-1* contains specifications and latest design features of these positive-displacement pumps. Standard and modified models are illustrated in the bulletin. Milton Roy Co., 1300 E. Mermaid Lane, Philadelphia 18, Pa.

Circle No. **26** *on Reply Card*

Foamglas insulation

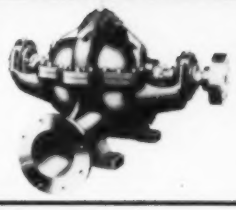
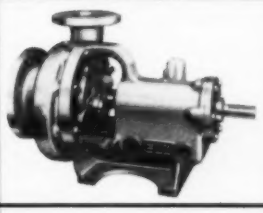
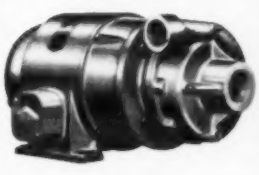
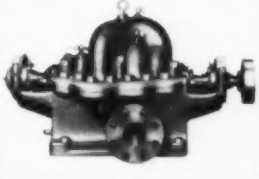
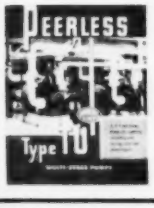
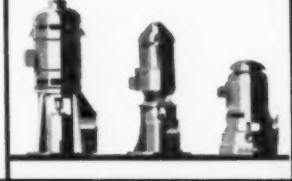
. . . for industrial equipment and piping: A set of six booklets, each of which suggests thicknesses, contains detailed drawings of installation

5 Peerless Pump Designs

that squarely meet every

LIQUID HANDLING REQUIREMENT

PEERLESS PUMPS

THESE ARE THE *Pumps*	ASK FOR *FREE* ENGINEERING BULLETINS
TYPE A AND TYPE AS GENERAL PURPOSE PUMPS Use these pumps in the widest range of water handling services. Single stage, horizontal split case design. Mechanical shaft seal construction available in sizes up to 4" (Type AS). Heads: up to 300 ft.; capacities up to 70,000 gpm.	 *Ask* FOR BULLETIN B-1300 & B-1350
TYPE DL AND DM CHEMICAL PROCESS PUMPS Combine quality with economy through a practical idea of component interchangeability between pump types. Oil and grease lubricated bearing housings. Packing gland or shaft seal designs. Air or water cooled back plates. Heads to 430 feet; capacities to 800 gpm. Pressures to 400 psig.	 *Ask* FOR BULLETIN B-1608
TYPE PE AND TYPE PB END-SUCTION PUMPS America's broadest line of economical, general purpose pumps. Horsepower range from ¼ to 150. Head range to 260 ft. Capacities up to 5500 gpm. Easy to buy, apply, install and maintain. Tens of thousands in use.	 *Ask* FOR BULLETIN B-2300
TYPE TU AND TYPE TUT MULTI-STAGE PUMPS 2,3,4 and 5-stage designs for supplying, circulating and boosting water and other liquids in moderate capacities against medium and high heads. Durable and dependable in operation. Heads up to 1660 feet; capacities up to 3000 gpm.	  *Ask* FOR BULLETIN B-1400
VERTICAL INDUSTRIAL SERVICE PUMPS Heavy duty, extra heavy duty and process service types for application to cooling tower service, tank pumping, etc. One of the proudest lines manufactured. Save on piping, always primed, require minimum floor space. Heads to 1000 feet; capacities: 30 to 40,000 gpm. HP range: up to 2500 h.p.	 *Ask* FOR BULLETIN B-505

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#39

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What's new (continued)

procedures, and describes insulation reports and finishes. Booklets may be obtained as a set or as individual copies. Titles are:

FI-104A *Low Temperature Equipment and Piping (Below 70° F)*

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FI-104D *Dual Temperature Equipment and Piping (—300 to +400° F)*

FI-104E *Underground Piping*

FI-104F *Insulation on Spheres (70 to —25° F)*

Booklets are available from Pittsburgh Corning Corp., One Gateway Center, Pittsburgh 22, Pa.

Circle No. **27** *on Reply Card*

Motor control centers

. . . concentrate control functions: *Bulletin SM 244 EFS* is a 16-page booklet describing the advantages of combining electric starters for motor controls in basic panel arrangements. Ample photographs illustrate the design of these centers. Square D Co., 4041 N. Richards St., Milwaukee 12, Wis.

Circle No. **28** *on Reply Card*

Static-bed adsorption

. . . for decolorizing, purification, and finishing of light distillates, lubricating oils and waxes: *Technical Information No. 401* is a 24-page publication which thoroughly discusses thermal regeneration, maximum permissible flow rates, and other design considerations in percolation adsorptive processes. Data not previously available in published form is included. Minerals & Chemicals Corporation of America, Menlo Park, N.J.

Circle No. **29** *on Reply Card*

Saraloy sheet

. . . for chemical resistance: *Bulletin 171-77* is an 18-page booklet giving detailed information on this flexible, thermoplastic and chemical resistant lining for processing equipment. Included are data on properties, methods of installation, and care and repair of linings made of Saraloy 898. Plastic Sales Dept., Dow Chemical Co., Midland, Mich.

Circle No. **30** *on Reply Card*

Pressure measurement

. . . of high accuracy: *Catalog 11-102* describes the Press-I-Cell which thermal regeneration, maximum per-

Memo: to all process engineers—

Why Tolerate Liquid Carry-Over?

...when METEX Hi-Thruput Mist Eliminators can deliver 100% efficiency!

• Whether it's on a vertical tube evaporator, a packed column, knock-out drum or a vacuum pipe still, there's no necessity, *today*, to permit poor liquid-vapor separation to pull product quality and profits down. With Metex, you have a unit that's *different*. Hundreds of thousands of openings and wire surfaces, so combined as to baffle uprising gas-liquid streams in multiples of thousands of physical separating contacts, can and *do effect complete gas-liquid-contaminant separation.*

No other unit delivers more efficiency, offers longer life or less maintenance. Used and specified by hundreds of process engineers, Metex Hi-Thruput Mist Eliminators are the standard of excellence wherever efficient entrainment separation is important to good production and profits.

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7-072

These BS&B Rupture Discs Can Give Your Pressured System...
Standard Rupture Discs, prebulged... available in a broad range of sizes, pressures and metals.
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Safety Head Division, Dept. 2-D7
7500 East 12th Street
Kansas City 26, Missouri

What's new (continued)

measures gas or liquid pressures with accuracies up to 1 part in 2000. Three pressure ranges of the instrument are available: 0-4 to 0-30 psi, 0-60 to 0-100 psi, and 0-150 to 0-1000. Absolute reading accuracy is greatest in the lower range. Fischer & Porter Co., 99 Jacksonville Road, Hatboro, Pa.

Circle No. **31** *on Reply Card*

Telemetering system

. . . uses pulse code for transmitting liquid level: *Bulletin CP-3012* is a 40-page description of this system and its component parts. Level in remote tanks is presented in digital form in control rooms or operating locations. The output signal can be fed into various types of data handling systems, too. Vapor Recovery Systems Co., Compton, Calif.

Circle No. **32** *on Reply Card*

Pneumatic controllers

. . . balance air pressures for control purposes: *Bulletin 5013* pictures and describes in detail the operation of Nullmatic controllers and control stations. Full-color diagrams explain the operation of these instruments, which can be used for local or remote installation. Moore Products Co., H & Lycoming Streets, Philadelphia 24, Pa.

Circle No. **33** *on Reply Card*

Ultrasonic gaging

. . . for non-destructive testing: *Bulletin No. V-200-257* gives data on using the Vidigage for measuring thicknesses of metals, glass and plastic from one side only. It can also be used to find corrosion, discontinuities and other structural flaws. Branson Instruments, Inc., 37 Brown House Road, Stamford, Conn.

Circle No. **34** *on Reply Card*

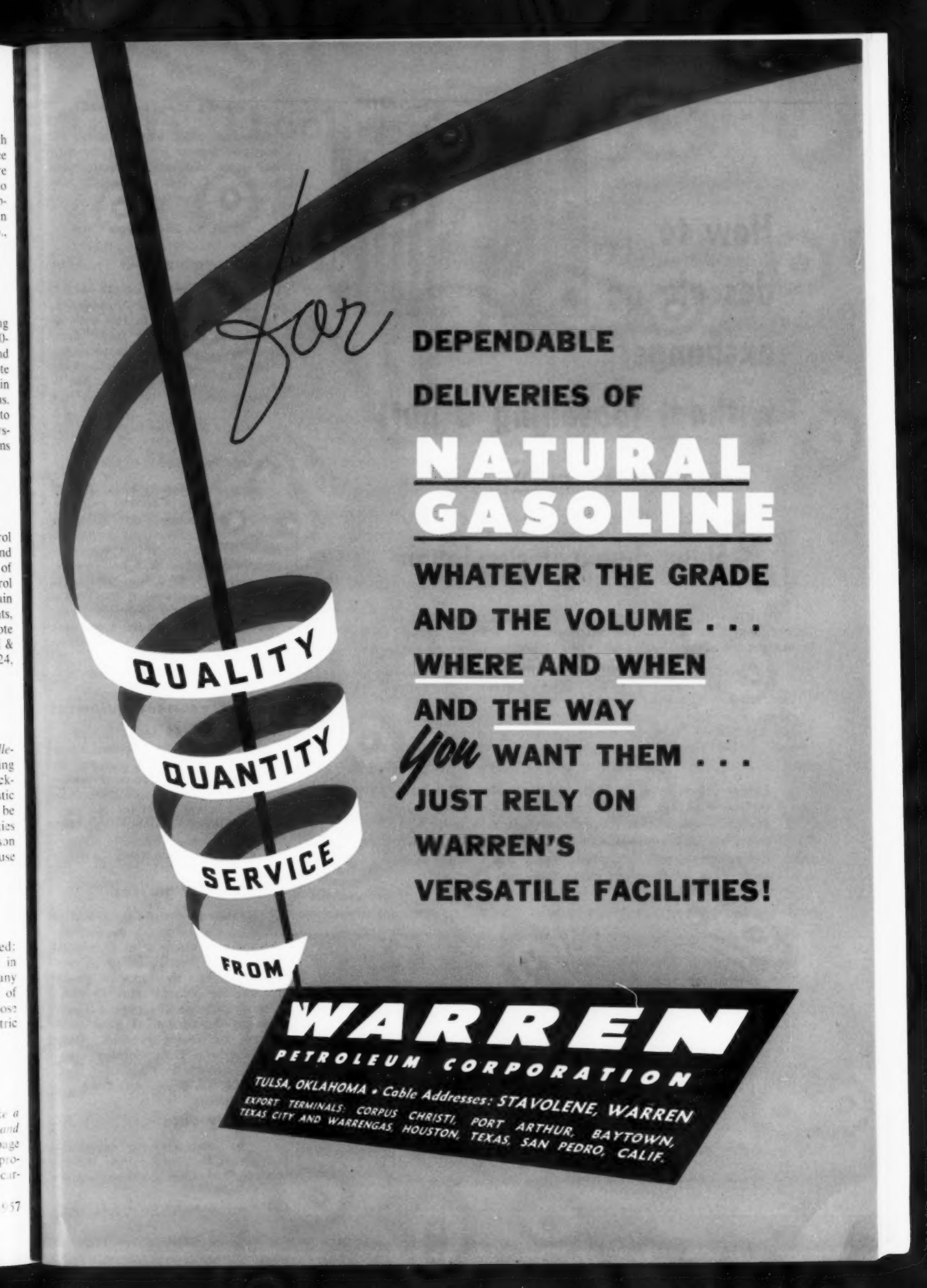
Fractional hp motors

. . . and how they are constructed: *Bulletin GEA-6424* is a brochure in 4-colors which describes with many illustrations the design features of this manufacturer's general purpose fractional hp motors. General Electric Co., Schenectady 5, N.Y.

Circle No. **35** *on Reply Card*

Motor maintenance

. . . in cartoon form: *How to Make a Motor Go . . . and Go, and Go, and Go, Bulletin 51X8581* is a 23-page adaption of a sound slide film produced by this company. Many car-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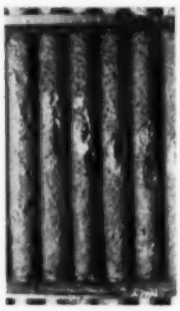

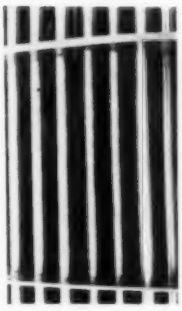

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Now you can get rid of sludge and scale without unheading exchangers or dismantling compressors ... with no rodding or scraping whatever...and best of all, without extensive downtime.

How? By in-place chemical circulation of specialized Oakite descaling compounds. These are formulated to dissolve the usual deposits built up in petroleum processing. To complete the advantages of this practical, time-saving procedure, Oakite methods and service are freely available.

Latest Oakite advance in chemical circulation cleaning is Oakite Drycid, acid in powder form. Useful in many descaling operations, this new product does away with heavy carboys, spillage, storage and return of 'empties'. Fumes are all but eliminated. Simply mix with water as used. Acid handling has never been so convenient.

A Technical Service Representative of the Oakite Petroleum Division is always ready to work with you on descaling and other maintenance cleaning problems. Call him, or write for special petroleum booklet to Oakite Products, Inc., 50D Rector Street, New York 6, N. Y.

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toons and simple diagrams along with text give a clear picture of the many techniques involved in successful maintenance of electric motors. Allis-Chalmers Manufacturing Co., Box 512, Milwaukee 1, Wis.

Circle No. **36** *on Reply Card*

Amoco refinery

. . . at Yorktown, Virginia: *Kellogram, Issue No. 3, 1957 series* describes the refinery in full with detailed sections of the major areas. Discussed are some of the considerations which led to site selection and design of the new refinery. M. W. Kellogg Co., 711 Third Ave., N.Y. 17, N.Y.

Circle No. **37** *on Reply Card*

Stainless steel

. . . in sheet and strip form: *Bulletin SS 38* is a 32-page booklet giving detailed information on Allegheny stainless steel. Twenty tables include information on corrosion resistance, fabrication properties, and weights per lineal foot in various widths and gages. Other sections of the booklet give suggestions for the proper selection of stainless steel for many uses. Allegheny Ludlum Steel Corp., Oliver Building, Pittsburgh 22, Pa.

Circle No. **38** *on Reply Card*

Waste-treatment equipment

. . . for large and small industries: *Bulletin No. 315-11* describes equipment used for solids removal by screening, sludge removal, skimming, settling and flocculation. Also described is equipment for dissolved-air and gravity flotation. Chain Belt Co., Milwaukee 1, Wis.

Circle No. **39** *on Reply Card*

Commercial glasses

. . . and their properties: *Bulletin B-83* discusses at some length the mechanical, thermal, electrical and chemical properties of these materials. A two-page table lists the types of glasses that can be obtained plus 19 properties of each one. The book is a good technical description of glass as a material for design purposes. Technical Products Div., Corning Glass Works, Corning, N. Y.

Circle No. **40** *on Reply Card*

Hastelloy data

. . . for designers and engineers: *Hastelloy Corrosion-Resistant Alloys, Bulletin F-30,601* is a 104-page, com-

Are YOU Looking for a BETTER Job?

Petroleum Processing is again expanding its editorial staff, and its editors are looking for a man with technical training to fill the opening of assistant editor.

The job offers the man we select an interesting opportunity in an exacting field of activity. He will have the chance to get better acquainted with the broader aspects of the petroleum processing industry, to meet and talk with its top-notch technical people, to be "in the know" about new developments in the industry even before they are announced. He will be affiliated with a dynamic, fast-moving publication, backed up by the largest and most progressive business magazine publishing firm in the world.

Here are the specifications:

Education: If you are the man we want, you're a graduate engineer, with a B.S. in chemical engineering or industrial engineering, with perhaps a few extra courses in business or economics. You were in the top third of your class scholastically.

Industry Experience: You have had some practical experience (although maybe only a few years) in our industry. You are now employed by an engineering firm, or in the engineering department of a petroleum or chemical company, and associated in some technical capacity with petroleum refining, petrochemical manufacturing, or natural gasoline recovery. You know the kind of engineers who read Petroleum Processing, and the kind of problems they are up against.

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Personality: You are curious about "why" and "how" things work, and you have the ability to explain their workings to others. You are able to organize your own work, and you have initiative to push ahead and get things done. You like meeting people and talking with them, yet at the same time you are a good listener. You are not a "glad-hander."

Location and Duties: You would welcome the chance to work in New York City, and you don't mind sitting behind a desk for a while, editing and rewriting other people's copy. Later (just as fast as you learn the ropes) you expect that you'll be given field assignments to gather data and write original articles.

Salary: You are now earning a respectable salary, and the chances are that this position will pay you even more right now—besides offering you the opportunity to rise more rapidly than you now expect to.

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Petroleum Processing
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New York 36, N. Y.

• If we think you are a qualified candidate, we will make arrangements for a personal interview. All replies will be held in the strictest confidence.

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The growing use of platinum catalysts in reforming feed stock emphasizes the importance of pre-removing trace metals such as arsenic, lead and sulphur compounds. Platinum catalysts are poisoned by these substances in quantities even as small as ten parts per billion.

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plete information source on these four nickel-base alloys—Hastelloy alloys B,C,D and F. Chemical composition, physical and mechanical properties, comparative resistance to corrosive, and laboratory data on penetration are some of the data offered in this reference book. Separate sections are devoted to welding, working and machining the alloys. Haynes Stellite Co., Division of Union Carbide Corporation, 420 Lexington Ave., N.Y. 17, N.Y.

Circle No. **41** *on Reply Card*

Semi-steel valves

. . . of high tensile cupola cast iron: *Bulletin V-203 Rev. 1* covers the entire line of Rockwell-Nordstrom valves. Featured in this revised listing and description are cutaway photos showing in detail the working parts of the valves, and information on methods of lubricating this valve. Meter and Valve Division, Rockwell Manufacturing Co., 400 North Lexington Ave., Pittsburgh 8, Pa.

Circle No. **42** *on Reply Card*

Fire protection

. . . with automatic sprinklers: *The A, B, C's of Fire Protection* is a 35-page booklet discussing the nature and advantages of fire protection systems. Included is a review of insurance savings and other benefits of adequate protection measures. Described are many ways of detecting and fighting fires with permanently installed equipment. Automatic Sprinkler Corp. of America, Youngstown 1, Ohio.

Circle No. **43** *on Reply Card*

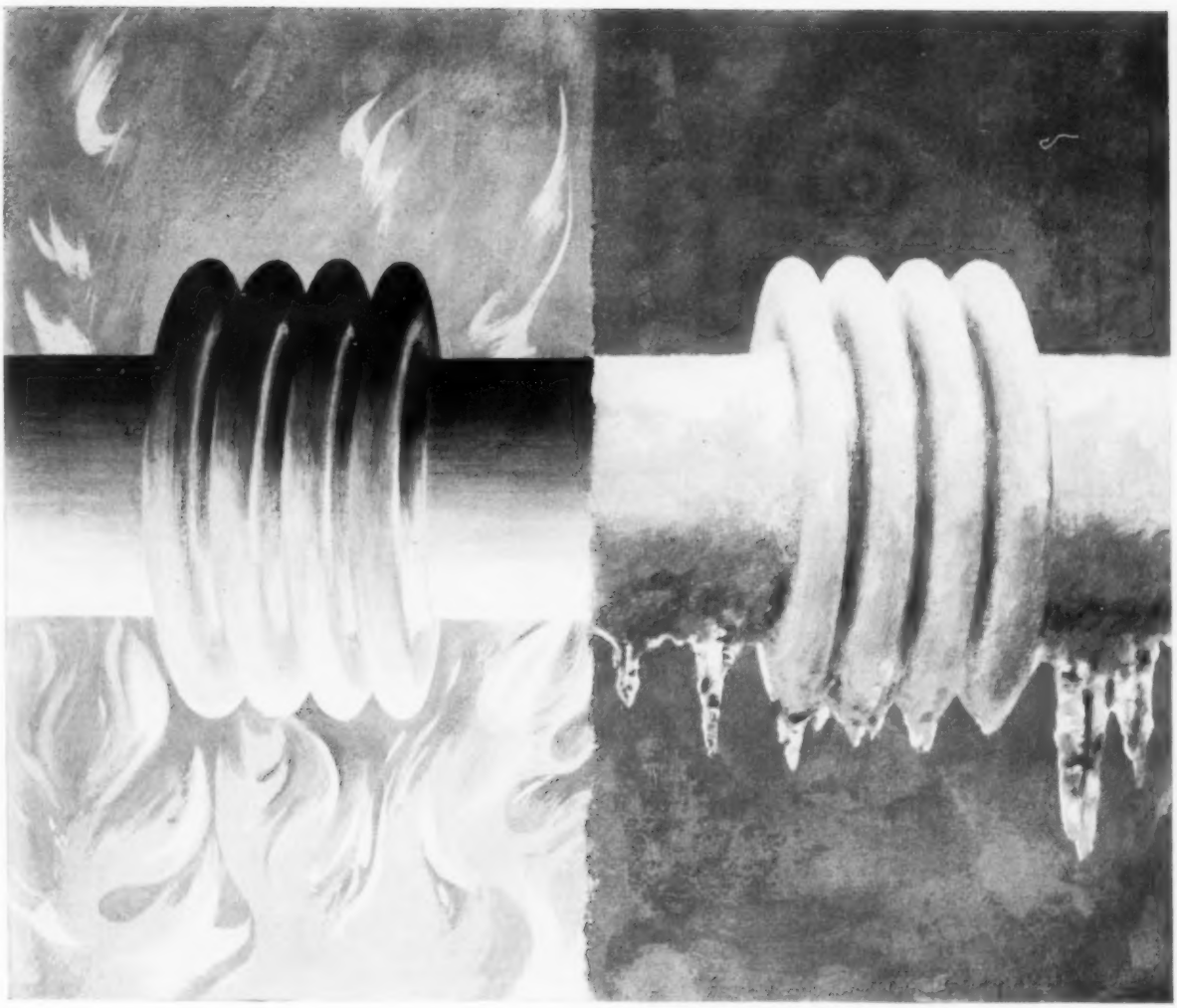
PVC valves

. . . and fittings: *Walworth Rigid Polyvinyl Chloride Valves and Fittings* is a bulletin about these pipe fixtures. Of special interest in this release is a 4-page application chart that shows exactly under what service conditions this material will function. A section on assembling these plastic fittings is also included. Walworth Co., 60 East 42nd St., N.Y. 17, N.Y.

Circle No. **44** *on Reply Card*

Teflon packings

. . . for hot or cold chemical service: *Bulletin No. P-325* lists the many types of mechanical packing available from this manufacturer under the trade name Chemlon. Both braided packing and molded or machined rings



HOT OR COLD

Sola-Flex® joints are designed for temperature extremes

FROM LIQUID OXYGEN at –300 F, to extremely hot materials at 2000 F, Sola-Flex bellows and expansion joints are engineered for long periods of rugged service under severe temperature extremes.

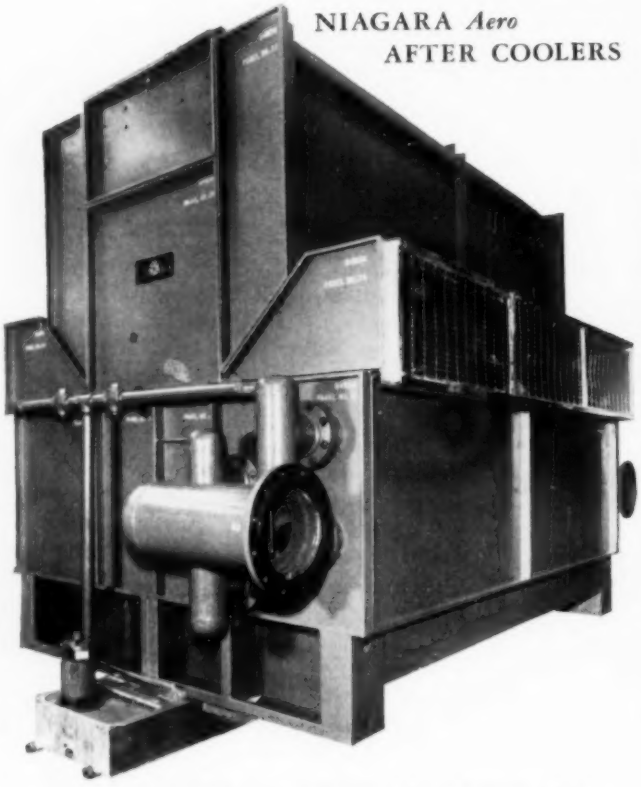
In cold oxygen lines, Sola-Flex joints reliably handle high pressures in extended positions and the U-span design offers no internal pockets to conceal dangerous contaminants. In high temperature applications, Sola-Flex joints require no external reinforcement rings, provide an economical solution to expansion problems.

Hot or cold, large or small, high pressure or low—no matter what your particular piping need, experienced Solar engineers can recommend exactly the right expansion joint for you. Write today for the latest Sola-Flex catalog. Department D-42, Solar Aircraft Company, San Diego 12, California.

Sola-Flex Bellows and Expansion Joints for industry are designed and manufactured by Solar Aircraft Company

SOLA SOLAR FLEX®

(To obtain more data on advertised products see page 230)



ECONOMICAL COOLING OF GASES and COMPRESSED AIR

● Cooling gases or cooling and removing moisture from compressed air, the Niagara *Aero* After Cooler offers the most economical and trustworthy method. Cooling by evaporation in a closed system, it brings the gas or compressed air to a point close to the ambient temperature, effectively preventing further condensation of moisture in the air lines. It is a self-contained system, independent of any large supply cooling water, solving the problems of water supply and disposal.

Cooling-water savings and power-cost savings in operation return your equipment costs in less than two years. New sectional design reduces the first cost, saves you much money in freight and installation labor and in the expense of upkeep.

Niagara *Aero* After Cooler systems have proven most successful in large plant power and process installations and in air and gas liquefaction applications.

Write for Descriptive Bulletin 130

NIAGARA BLOWER COMPANY

Dept. PP-7 , 405 Lexington Ave. New York 17, N. Y.

District Engineers in Principal Cities of U. S. and Canada

are described. A service table helps in the selection of the right packing for every possible service condition. Crane Packing Co., Morton Grove, Ill.

Circle No. **45** *on Reply Card*

High-vacuum equipment

. . . for both laboratory and industrial uses: *Bulletin 1-1* is a general catalog of equipment used in obtaining pressures below one millimeter Hg. Included are pumps capable of reaching 10^{-5} and 10^{-9} mm Hg, traps and valves, high vacuum gauges, leak detectors, stills and furnaces. Rochester Division, Consolidated Electrodynamics Corp., 1775 Mt. Read Blvd., Rochester, N. Y.

Circle No. **46** *on Reply Card*

Did you miss these?

The following items, reviewed originally in March, have aroused considerable interest among readers. These items are repeated here briefly as a service to those who might have missed them the first time they appeared. For more details or literature, please use the regular Reply Card in this issue.

Instrument terms

. . . and what they mean: *SAMA Tentative Standard, RC-12-1955* is titled "Accuracy and Sensitivity Terminology as Applied to Industrial Instruments." These tentative standards of the Scientific Apparatus Makers Association define many terms used in describing and specifying industrial instruments. Copies may be obtained from Hapton M. Auld, Executive Secretary, Recorder-Controller Section, SAMA, 522 Fifth Ave., N. Y. 36, N. Y.

Circle No. **47** *on Reply Card*

(Continued on p. 260)

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• Carbon Steel • Stainless • Large O.D.
Widest Range of Sizes & Specs in the U.S.
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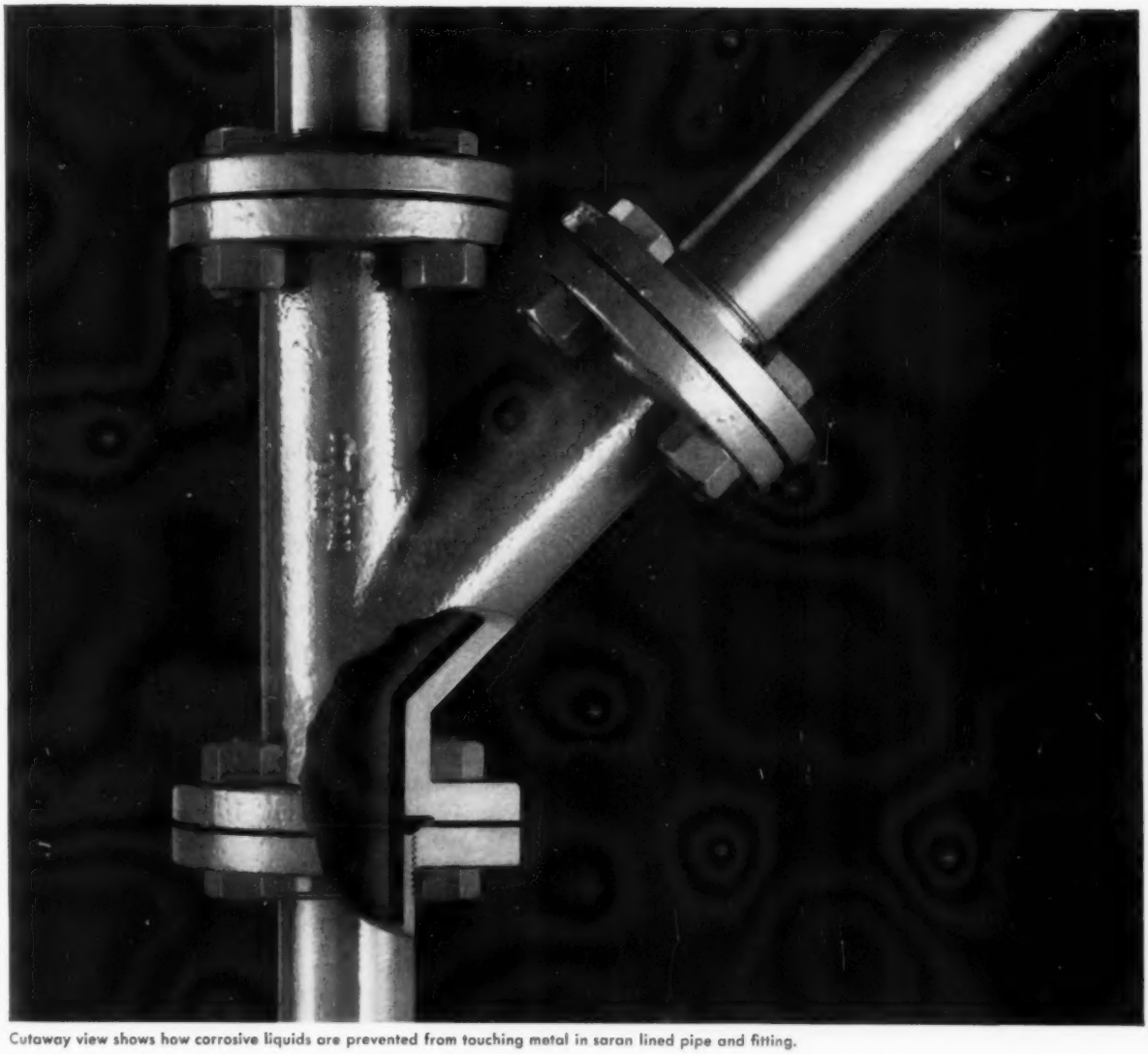


Cutaway view shows how corrosive liquids are prevented from touching metal in saran lined pipe and fitting.

You can see why saran lined pipe is so corrosion resistant!

It's steel pipe lined with durable saran . . . acids, alkalies can't harm it

Corrosive liquids won't harm this pipe, its fittings or its valves. A thick, tough saran lining completely protects it from commonly used acids, alkalies, other corrosive liquids.

It's strong, too. Saran lined pipe will withstand working pressures up to 300 psi. Saran lined valves and fittings are available for working pressures of 150 and 300 psi. You can use the same supports you would use with ordinary steel pipe.

Ease of fabrication will keep your installation costs down. Cutting and threading can be readily accomplished in the field with conventional hand tools or power equipment.

For tomorrow's protection, investigate saran lined pipe today. THE DOW CHEMICAL COMPANY, Midland, Michigan.

SARAN LINED PIPE COMPANY
DEPT. SP1591F-1
2415 BURDETTE AVENUE
FERNDALE 20, MICHIGAN

Please send me information on saran lined pipe, fittings and valves.

Name_____ Title_____ Company_____

Address_____ City_____ State_____

YOU CAN DEPEND ON DOW

(To obtain more data on advertised products see page 230)

HOW! PUMP USERS—

BASE MOUNTED OR CLOSE COUPLED . . . Pick your Pump to fit your needs

Choose from Dean Brothers companion lines of standard commercial centrifugal pumps—base mounted or close coupled.

When yours is a process service such as . . .

- Heat Transfer
- Reflux
- Vacuum
- Reactor Cooling
- Filter System
- Tar Products Recovery
- Regeneration
- Reforming

. . . THEN LOOK AT THE "GS" LINE BEFORE YOU BUY

Type "GS"—for General and Chemical Services

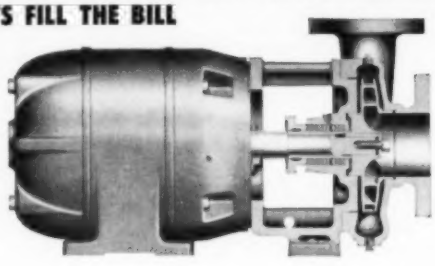
- 7 INTERCHANGEABLE SIZES—up to 600 gal. per min.
- TOTAL DYNAMIC HEAD—up to 275 ft.
- Available from stock in ALL IRON, BRONZE FITTED or STAINLESS STEEL Construction.

For complete information, send for Circular No. 190.

For industrial services such as . . .

- Wash Water
- Product Cooling
- Refrigeration
- Swimming Pools
- Air Conditioning
- Car Unloading
- Water Softening
- Condensate Return

. . . DEAN BROTHERS "GSC" CLOSE COUPLED UNITS FILL THE BILL



Type "GSC"—for General Service

- 7 SIZES—up to 600 gal. per min.
- TOTAL DYNAMIC HEAD—up to 275 ft.
- Available in ALL IRON, BRONZE FITTED or ALL BRONZE Construction.

Available with either Foot Mounted Motor Frame, as shown, and with Round Motor Frame.

For complete information, send for Circular No. 191.

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EST. 1869

323 West 10th St., Indianapolis 7, Ind.

Fin-tube heat exchangers

. . . are available in a wide variety of metallurgies: *Bulletin FH-3* lists the many types which are available with longitudinal, integral fins. They are built in standard sizes to facilitate series-parallel combinations for special applications, but also permit disassembly and setup for another use. Included in the bulletin are two data charts of finside coefficient and pressure drop. Alco Products Inc., 30 Church St., N. Y. 8, N. Y.

Circle No. **48** *on Reply Card*

Engineering manual

. . . for clutches and clutch-couplings: *Engineering Manual Number 56* is a 78-page booklet that will aid those who design mechanical power transmission setups. The products described are useful in connecting shafts of almost all types of prime movers and driven equipment. Contained within the book are many hints on proper selection of this type of equipment. Marland One-Way Clutch Co., 561 West Hillgrove Ave., La Grange, Ill.

Circle No. **49** *on Reply Card*

Drum heater

. . . for 55-gal steel drums features a quick-action toggle clamp, a built-in, 3-heat switch, and wiring circuits to assure uniform heating.

At the high setting of 230 volts input, each heater delivers 3,000 watts. At the medium setting 1500 watts are delivered, and the low setting is 750 watts. Actual heat input into the drum, without thermal insulation, is said to be 65 to 85% of the generated wat-

• • •

tage. This figure depends on the condition of the container as well as the heat absorbing properties of the contents.

When applied to a drum filled with hard-to-remove material—such as plastics, adhesives, or highly viscous material—the wattage concentration of the heater through the face of it is low enough to prevent coking or burning the contents. Acra Electric Corp., Franklin Park, Ill.

Circle No. **50** *on Reply Card*

Non-metallic pipe

. . . has many of the advantages of both metal and extruded plastic pipe. It can operate from —65 to 260°F, is resistant to most corrosives, is a non-conductor, has light weight and high strength, and can operate in the pressure range of 300 to 1000 psi.

The pipe is made of multiple layers of braided glass reinforced and impregnated with cast epoxy. The threads are formed by upsetting and do not weaken at the joints. All ends are coated with epoxy to protect them against corrosion. Many fittings, including threaded nipples, elbows, flanges, couplings, tees and service saddles are available. The Fibercast Corp., P. O. Box 727, Sand Springs (Tulsa), Okla.

Circle No. **51** *on Reply Card*

Storage tanks

. . . for many uses: *Graver Standard Storage Tanks* is a 20-page booklet showing the wide range of tanks and vessels which can be obtained from this company. Included is a table of dimensions for standard welded tanks of from 20 to 200-ft diameters. Graver Tank & Manufacturing Co., Inc., East Chicago, Ind.

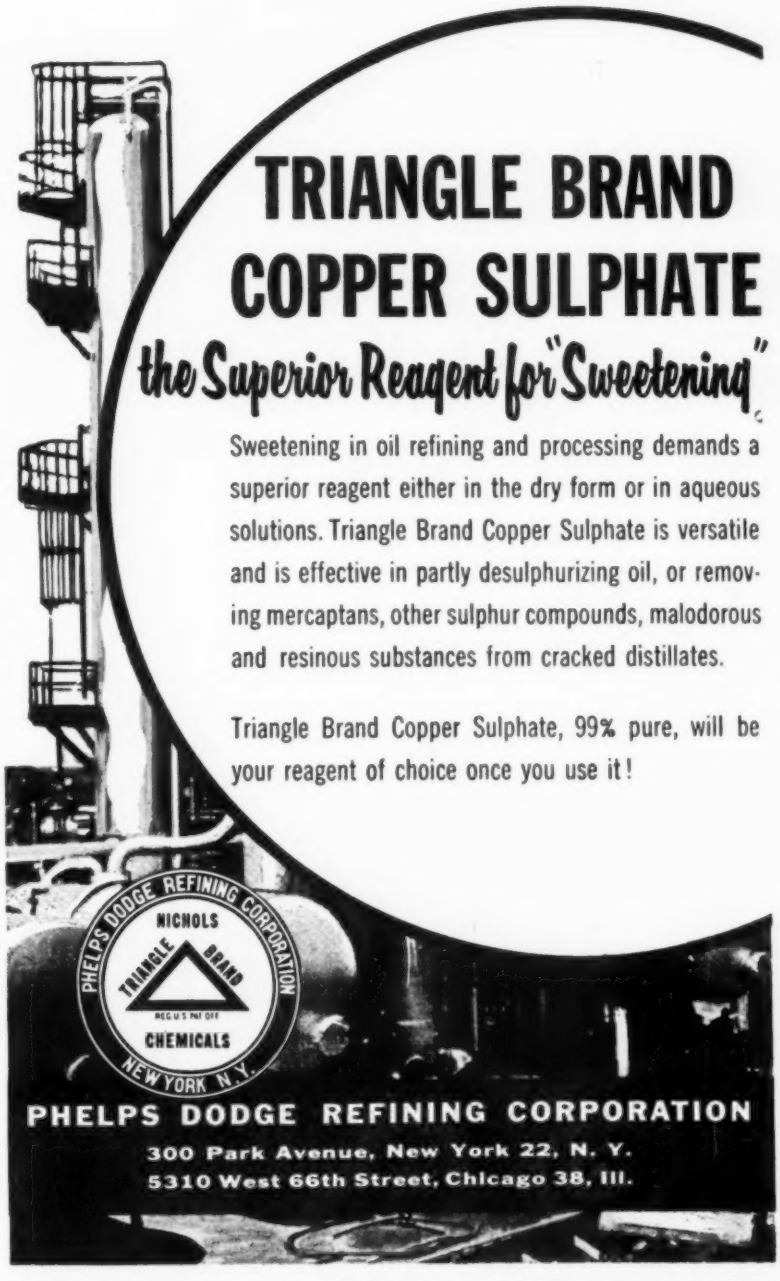
Circle No. **52** *on Reply Card*

Flowmeter

. . . for hard-to-handle fluids such as bunker oils, still bottoms and asphalt has a capacity range up to 450 gpm.

The positive displacement meter is available in sizes from 1 to 6 in., and has an operating temperature range up to 660°F. Operating pressure can be as high as 600 psi. Accuracy of the meter is guaranteed at ¼% for the 1-in. meter and ½% for the 2 to 6-in. sizes. The body of the meter is meehanite iron, enclosed in a steel steam jacket designed for 15 psi service. Brooks Rotameter Co., Lansdale, Pa.

Circle No. **53** *on Reply Card*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Sweetening in oil refining and processing demands a superior reagent either in the dry form or in aqueous solutions. Triangle Brand Copper Sulphate is versatile and is effective in partly desulphurizing oil, or removing mercaptans, other sulphur compounds, malodorous and resinous substances from cracked distillates.
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(To obtain more data on advertised products see page 230)

A MESSAGE TO AMERICAN INDUSTRY • ONE OF A SERIES

Is Industry Creating A New Breed of "Bonus Babies"?

THE STARTING SALARIES offered to this year's June graduates give the impression that industry is creating a new breed of "bonus babies." This is the term baseball fans apply to sturdy youngsters whose talent for hitting and throwing gets them payments of up to $100,000 and other benefits for signing a contract.

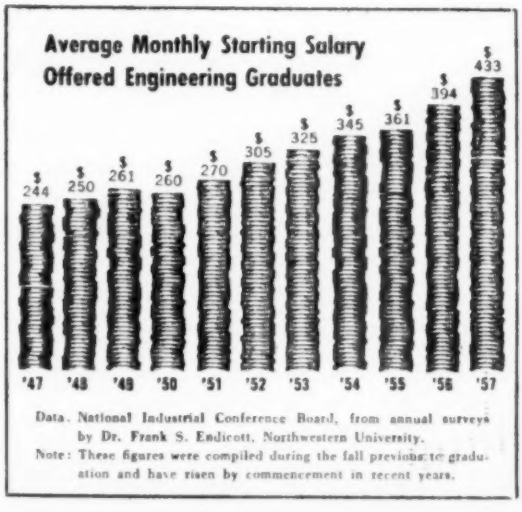
For several years industry's demand for young college graduates, especially in science and engineering, has outrun the number receiving degrees. Competition for these young people has steadily pushed up the starting salaries and has induced many companies to indulge in lavish recruiting programs. This year engineering graduates are being offered well over $400 a month, and even liberal arts graduates find numerous offers at $400 or more. Only ten years ago the salaries offered senior engineering students averaged less than $250 a month.

But any employer who assumes that high starting salaries alone will assure him the number of June graduates he wants is likely to be disappointed. A recent study by the McGraw-Hill Classified Advertising Division shows that most young engineers and scientists going into industry are more interested in their opportunities and in a company's future than they are in the size of their first paycheck.

Money Isn't Everything

In the McGraw-Hill survey, 2,596 recently-hired engineers and scientists employed in 57 companies listed the factors they had considered before accepting a position. The replies of the younger engineers and scientists—those with less than five years' experience — have great significance for employers who want to make any impression in the highly competitive market for college graduates.

- **Potential growth of the company** was listed by more young engineers and scientists than any of the 42 other items on the list as a factor that influenced greatly their decision in accepting a position.
- **Challenging opportunity** was second.
- **The company's prestige and reputation** ranked third.



Data: National Industrial Conference Board, from annual surveys by Dr. Frank S. Endicott, Northwestern University.
Note: These figures were compiled during the fall previous to graduation and have risen by commencement in recent years.

- **Progressive research and development program** was fourth.
- **Starting salary** ranked only **seventh.**

Job and Future Most Important

As a group, the factors relating to the nature of the job, its future and the company's future had by far the greatest influence in attracting young engineers and scientists to their present positions. These include three of the top four attractions—potential growth of the company, a challenging opportunity and a progressive research and development program. Other factors in this group are the company's facilities, quick advancement, self-direction or little supervision, chance to work in a certain field, small size of company and rewards for individual accomplishment.

The second most important group of attractions had to do with prestige. These include the company's prestige and reputation, executive or professional standing and association with leading men in the field. **Third in importance were financial considerations** — starting salary, regular salary increases, financing of relocation, paid vacations and holidays.

A less important group of factors influencing young scientists and engineers were essentially social. Geographic location and educational facilities in vicinity ranked fairly high. But recreational facilities, suburban or country living, pleasant housing and cultural considerations had little appeal.

Ranking lowest, by a good margin, were factors having to do with security—permanent position; health, life and surgical insurance; retirement or pension plan; and sick leave.

It is interesting to note that some of the factors which influenced the **smallest** percentage of young engineers and scientists were country club memberships, use of company car, at-cost or low-cost eating place, travel opportunities abroad and being able to buy the company's products at a discount.

A Lesson For Employers

The lesson of this survey to employers who hope to recruit more young engineers and scientists is clear. High salaries and other financial appeals are important. But, **at a time when high starting salaries are offered in abundance, our young graduates are interested even more in being with companies that will grow and in jobs that will permit them to grow. They are interested in jobs that offer opportunities for advancement, financially and professionally.**

* * *

Were the young scientists and engineers who participated in the survey trying to impress somebody with their motives? If so, it could only have been to impress themselves, for all were asked to return their questionnaires unsigned.

What Factors Influence the Job Selections of Young Engineers and Scientists?

Factors Influencing Decision Greatly	Percent Listing Factor
Potential growth of company	55%
Challenging opportunity	53
Company's prestige, reputation	44
Progressive research and development program	41
Geographic location	37
Permanent position	35
Starting salary	34
Educational facilities in vicinity	33
Regular salary increases	31
Chance to work on specific project, or in certain field	27
Company's facilities (laboratories, technical libraries, etc.)	25
Tuition for graduate study	25

Based on replies by recently-hired engineers and scientists with less than five years' experience to questionnaire distributed by McGraw-Hill Classified Advertising Division.

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Donald C. McGraw
PRESIDENT

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First in a New Generation

TIDEWATER'S new 130,000 b/d Delaware Refinery is now almost completely onstream —an event the petroleum processing industry has been anticipating ever since the project was first announced in 1954.

In the course of gathering the information published in this issue about the new plant, we on the editorial staff of PETROLEUM PROCESSING have spent many days at the refinery. We've watched it grow and take shape; we've examined it in considerable detail; we've talked with its designers and builders and operators.

As a result, we feel closer to it than we've ever felt to any other new plant. And we probably know more about it on an over-all basis than any other "outsider."

Because of this closeness we are inclined to make some observations about the project. They are not necessarily original nor profound observations. But they are verified from first-hand knowledge and are worthy of the industry's attention.

1—This plant is big

Bigness, of course, is relative, and depends to some extent on what yardstick you use for comparison. The Delaware Refinery isn't the biggest plant in the world or even in the U. S. in terms of crude capacity. There are bigger ones. It is, however, the largest brand-new refinery ever built as a single coordinated project. And it includes some of the largest processing units ever erected.

Its real bigness, however, lies in the thinking behind it—in the unconfined viewpoint of a management group which could visualize a refinery unlike any existing one.

It takes big thinking—and deeds to back the thoughts—to build single large units instead of many smaller ones, to install automatic data loggers on every major unit, to use remote gaging entirely on all crude and product tankage, to install enough automatic blending to handle all product.

2—It has changed cost concepts

A pretty good rule of thumb during the past decade has been that a complete refinery should cost in the neighborhood of $1,000 per barrel of daily operating capacity. The new Tidewater Delaware Refinery was originally programmed three years ago on that basis—100,000 b/d at a cost of $100-million. It ended up at 130,000 b/d and a cost of $200-million. That comes to over $1,500 per barrel.

It costs more to build a refinery of the nature that Tidewater now has—largely automatic in operation, and with above-normal safety factors in both metallurgy and spares.

Only time will tell whether or not these "extras" will result in reduced operating and maintenance costs sufficient in magnitude to offset the increased investment.

3—It took courage to build

Even before Tidewater decided to build its new refinery in Delaware it displayed courage of the sort which few companies have shown in the past. The first decision—to leave Bayonne, N. J., and give up an established refinery—was not an easy one to make. The company had been refining crude there since the 1880's. Few companies are willing to face up to the fact they are in an untenable position, announce to the world why, and take such bold measures as Tidewater did to correct the situation. Most of us would stay put and face economic suicide.

The next big decision—to design and build a refinery as advanced as the Delaware Refinery —also took courage. You don't build single large units and put all your eggs in one basket unless you are convinced you know what you are doing —and have the courage of your convictions. You don't go into extensive data logging and computer programs of the sort Tidewater has installed unless you have foresight—and courage.

Truly, as Tidewater's president David T. Staples said during the dedication of the Delaware Refinery, it is "the first in a new generation of petroleum refineries."

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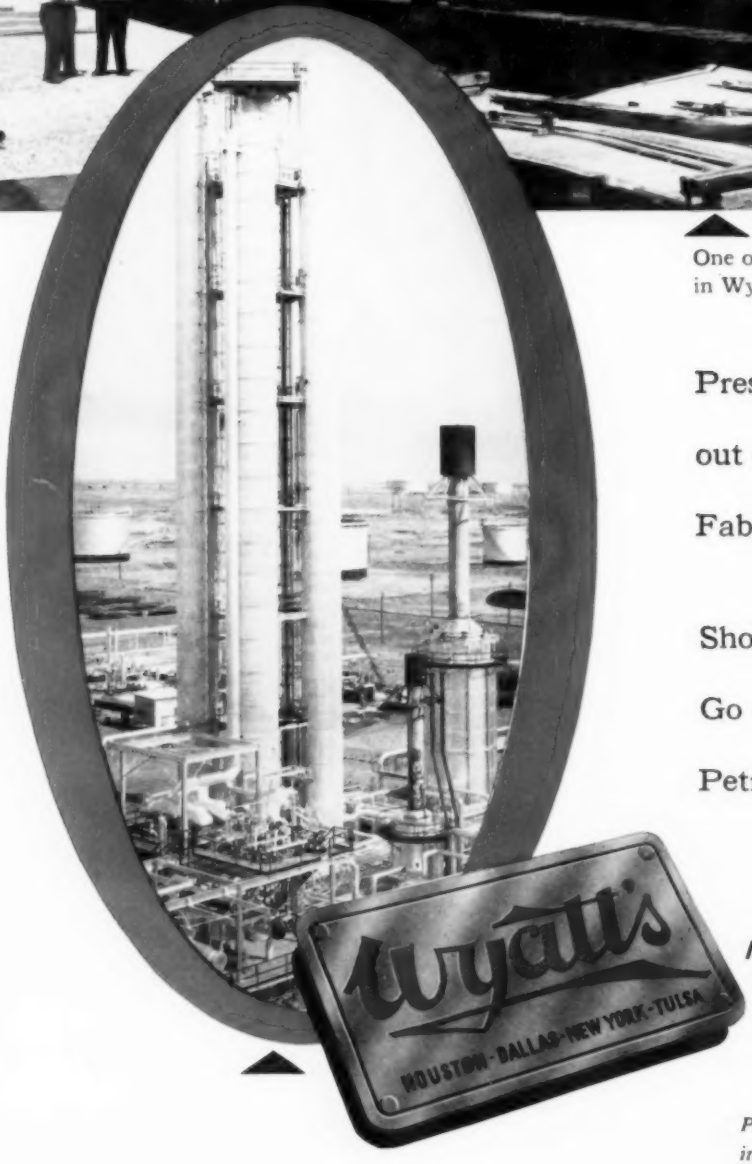

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